THE
POPULAR SCIENCE
MONTHLY.

SEPTEMBER, 1914

AN EXPEDITION TO THE CORAL REEFS OF TORRES STRAITS

By ALFRED GOLDSBOROUGH MAYER

EARLY in September, 1913, the expedition of the Department of Marine Biology of the Carnegie Institution of Washington arrived at Thursday Island in Torres Straits off the northern end of Cape York.

Thursday Island owing to the deep water in its vicinity has grown to be a busy port of call, although it is barely a mile in length and is so completely surrounded by the larger members of the archipelago that only the most detailed British Admiralty charts records its name, and even the painstaking Captain Cook who first sailed past it in the "Endeavour" in 1770, merely notes it as one of the Prince of Wales Islands.

Yet to our eyes it seemed an important place. Four of us—Clark, Harvey, Mayer and Tennent, together with Mr. John Mills, the able engineer of our naptha launch, had come nearly half the distance around the world from the eastern states of America, while Mr. Potts had left his cloistered quarters in Trinity Hall, Cambridge, and Mr. E. M. Grosse, the artist, had joined the expedition in Sydney.

Thursday Island was the intended objective of our journey for Saville-Kent in his beautifully illustrated book upon the Great Barrier Reef of Australia had especially designated it as being the site *par excellence* from which to study the coral reefs of Torres Straits.

Our surprise and disappointment was great therefore when we found the coral reefs to be overwhelmed with a layer of mud above which only the largest corals could raise their heads and thrive. The region seemed an ideal one only for masses of fleshy, dull olive-green alcyonaria (*Sarcophyton*) superficially resembling huge lichens several feet in diameter. The remarkably strong currents with their freight of silt and mud were fatal to luxuriant coral growth and the echinoderm life was hopelessly deficient, so that even the cheerful Clark, as enthusiastic a collector as ever lived, was in despair.

Fortunately, Mr. Charles Hedley, of Sydney, the distinguished student of coral reefs, had in a measure prepared us for disappointment and had kindly told us of the clear blue ocean water and rich coral reefs surrounding the Murray Islands 120 miles from Thursday Island, within 5 miles of the outer edge of the Great Barrier Reef and 75 miles south of the coast of New Guinea.

To the Murray Islands therefore we saw we must go with all speed, a feat, however, somewhat easier to plan that to accomplish, for in the intervening region were hundreds of uncharted coral reefs, and of all the fleet of schooners at anchor in Thursday Island harbor but one would venture to undertake the hazard of the voyage.

No sooner did the owner of this daring craft agree to take us, however, than he and his vessel disappeared in the night, leaving us stranded upon Thursday Island.

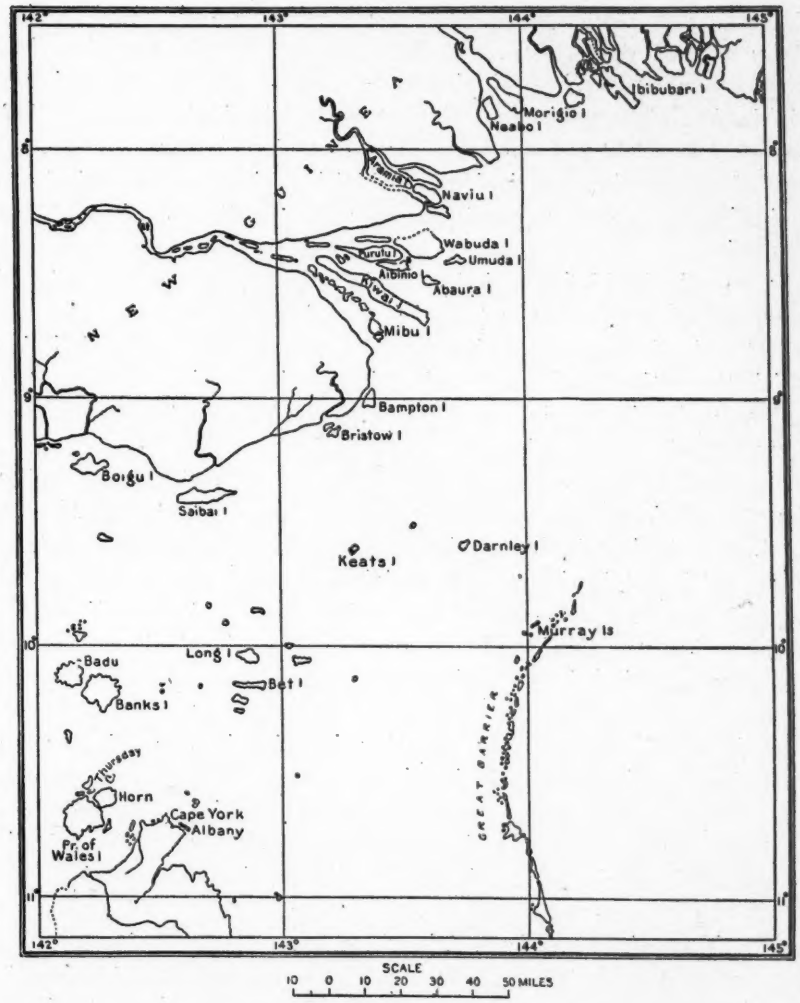
In response to kind letters of introduction from the British Ambassador Lord Bryce, the officers of the Australian government were most cordial in their efforts in our behalf, and never did we appreciate their generous aid more deeply than in the present emergency, for at the request of the Honorable W. M. Lee-Bryce, Esq., resident of Thursday Island, Messrs. Arthur and Hockings permitted the use of their power schooner *Kestrel* to transport Messrs. Clark, Grosse, Harvey, Potts and Tennent to Darnley Island only 25 miles from the Murray Islands.

In the meantime, Mr. Mills and the director of the expedition set out to sea in a small launch to search for the truant schooner which we finally found snugly anchored in the lee of the peak of a beautiful palm-clad island within 25 miles of Endeavor Strait.

The "recapture" of the schooner was speedily effected and soon we were scudding over the waters toward the elusive Murray Islands. Our crew were black, very black, and each man's nose was pierced so as to confer as romanesque an outline as it is possible to attain with an originally negroid nasal organ. Moreover, the captain's ears were slashed and torn in a manner to delight the heart of a rat-catching terrier. His weather-beaten face bore many a scar, and one eye seemed to have seen better days, but more perfect discipline one never saw maintained upon a schooner than that enforced by our erstwhile head-hunting commander. They sprang to obey his almost whispered orders with an alacrity that would have done credit to the crew of a man-of-war.

Without chart or compass we sailed over a sea marked "dangerous" on the maps we might have had but chose to dispense with.

Each day we threaded our way among the intricate passages between jagged coral reefs, keeping in the deep blue between the patches of emerald-green edged with foaming breakers; and always the steady southeast trade wind urged us onward. At night, we lay at anchor close



MAP OF TORRES STRAITS.

under the lee of reefs and the drowsy roar of the ocean lulled us into sleep.

At Darnley Island we found our associates most comfortably housed in the home of the magistrate, Mr. T. Arnold Williams, from which hospital roof, indeed, they were most unwilling to be "rescued."

But at last the peaks of the three extinct volcanoes which constitute the Murray Islands loomed through the tropic haze, and still struggling among the maze of reefs, we made for Maër Island, the largest of the group and anchored under the lee of the mountain wall by the side of its palm-edged beach.

As our naptha launch approached the shore, the sands became black with natives all gesticulating in much excitement, but we were most

cordially and kindly received by the magistrate and school teacher, John Stewart Bruce, Esq., who for more than twenty years has lived alone among the natives laboring to fit them to meet the oncoming of civilization. Throughout our stay on Maër Island, the constant kindness and excellent advice of Mr. Bruce was indispensable to the success of our studies, and incidents exhibiting his rare personal charm and high character we shall always recall as the happiest of our memories.

Through the kind permission of the government, we were allowed to occupy the courthouse and the jail for laboratory quarters.

The courthouse was an airy, cheerful one-roomed concrete building which the natives under the leadership and instruction of Mr. Bruce had succeeded in erecting after four years of the most strenuous and concerted effort in the history of the island.

The jail, on the other hand, was a flimsy hut of pandanus thatch, but it served admirably as a storehouse for our apparatus and supplies.

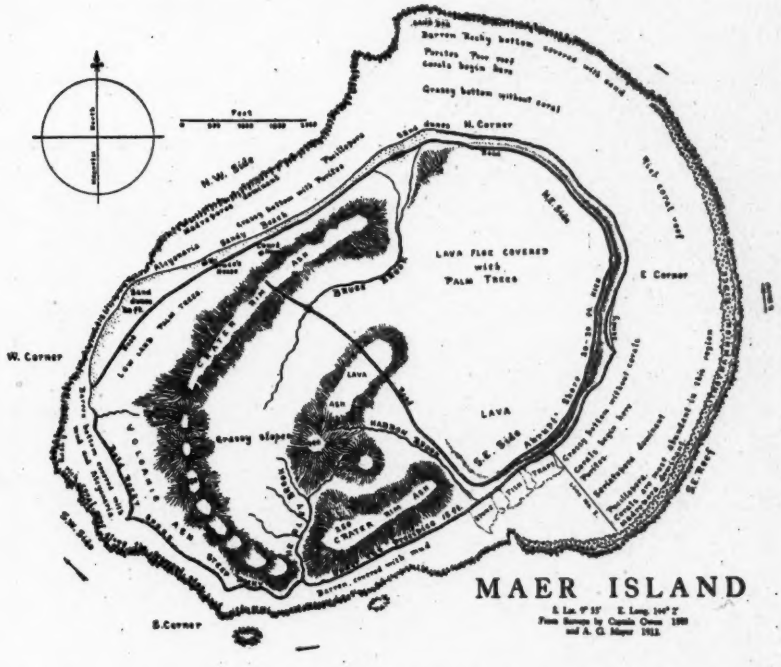
As may be imagined, our visit put an end to the orderly administration of island justice. Deferred jail sentences were henceforth the only sort that could be enforced upon wife-beaters and other disturbers of the serenity of the island, but an even more dreadful punishment was quickly devised by the chief, or Mamoose, who condemned malefactors to work for us.

This punishment, however, soon lost its sting in proportion as the fame of the achievements of Jimmie, our cook, became spread abroad. Four cups of strong coffee, five fish balls, a large piece of turtle meat, four bananas and a yam constituted an average 5:30 A.M. "breakfast" for our native assistants, so it may be imagined that starvation was not the rule of our camp.

The impression should not arise, however, that our native servants were reprobates, for those whom we chose were good and faithful. Indeed, we employed the same men who had served Professor Haddon, whose accounts have made the anthropological and geological aspects of the islands so well known.

Fortunately one of our party could claim the honor of Professor Haddon's personal friendship, an "open sesame" to the Islander's highest consideration, but despite the initial respect thus inspired, the natives soon decided that we of the scientific staff were all hopeless but quite harmless lunatics who were being taken around the world under the guidance of our engineer, Mr. Mills. Indeed the wonderful behavior of the launch and the miraculous achievements of "Johnmills" who could "saw iron" were soon immortalized in song and will doubtless remain as a revered tradition of the island.

Maër Island is an extinct volcano which in its active days burst through the old limestone floor of the wide Barrier Reef plateau which



as has been shown by Andrews, Griffith-Taylor and Hedley, was once above the sea but is now submerged to a depth of from 90 to 180 feet. Shattered fragments of the old limestone are found imbedded in the ash crater of the volcano.

On the western side of the island, the crater rim rises to a height of about 750 feet, the seaward slope being steep and evidently determined by the angle of repose of the ejected ash.

In later times, however, the volcano appears to have exploded and destroyed the northern part of the crater rim, out of the break in which there flowed a tongue-shaped mass of lava which now constitutes the northern half of the island. The last volcanic activity issued from a small ash-cone in the cup of the old crater, and then the island lapsed into its unbroken quietude.

A luxuriant growth of cocoanut palms, and forest trees now covers the old lava, while coarse grass grows rankly over the ash slopes of the crater. The torrential rains of the wet season from November to March

N.W.–S.E., SECTION OF MAER ISLAND. (Diagrammatic.)

have cut three ravines down the slopes, and in former times, before the coral reef grew seaward to protect the island, the sea commenced to cut into the shores, forming a precipice about 20 feet high along the southeastern side of the island.

But, after the volcanic fires had ceased, corals began to grow along the shores and soon the island was surrounded by a fringing reef. The steep seaward slope and outer edges of this reef provided the best foothold for the growth of corals, and no sooner did the old ones die than new growths took possession of the coveted space and thus the reefs pushed seaward from the shores and the old volcano was protected from the attack of the breakers which now break impotently upon the outer edge of the ever-widening reef.

As is always the case under these conditions, the reef advanced seaward most rapidly against the wind, for corals thrive best in agitated water which is free from silt. Thus the reefs are three times as wide on the southeastern as on the northwestern sides of the island, for not only is the water too calm for the most luxuriant coral growth on the leeward side, but the mud which is washed over the reef-flats during the rainy season interferes seriously with coral growth. It is due also to this fact that the reef—or platform—is narrow wherever the silt from the streams washes over it, and wide wherever it is covered with pure ocean water and exposed to the full force of the breakers.

Maër Island is oval, about three miles long and one and a half wide and the southeast trade-wind causes the water currents to sheer in opposite directions from the middle of the southeast shore, and eddies are formed at both ends of the island, and these deposit water-washed sand along the leeward side, thus forming dunes at the ends and a sand beach along the middle of the leeward side, and converting the originally oval shape of the island into a crescent with its horns and concavity directed down the wind. Indeed Hedley and Griffith-Taylor, and Wood-Jones have shown that the crescentic shapes of coral atolls are formed in this manner in obedience to the direction of the prevailing winds and currents.

In short, the width and character of the reefs surrounding Maër Island are determined by the shore conditions; and it is quite clear that the island has not developed in the midst of a preexisting reef-flat, but that the volcano was formed before the modern reefs began to grow around it. Moreover, they are all fringing reefs that have grown outward from the shore and thus the "lagoon" of the great southeast reef is only 18 inches deep and its bottom is of hard coral with none of the mud and occasional reef patches seen in the bottoms of all lagoons between barrier reefs and the shore.

Indeed according to a theory which has been put forth by Penck, and more recently by Professor R. A. Daly, barrier reefs originated

in a manner quite different from that of the recent fringing reefs of the Murray Islands. According to these students water was abstracted from the sea to form the great polar ice caps of the glacial epoch, and Professor R. S. Woodward has demonstrated mathematically that a still further lowering of level in tropical seas must have resulted from the attraction of the ice caps for the ocean surrounding them.

Thus the level of the tropical oceans may have been about 120 feet lower than at present. Now under these conditions the oceans would wash away the shores forming platforms along the tropical coasts at a level which would be about 120 feet below the present surface of the water.

Then when the ocean began again to rise, after the close of the glacial epoch, corals would grow along the outer edges of these platforms and thus Atolls and Barrier Reefs have been formed; the Atolls growing upon the truncated summits of mountains.

Andrews called attention to the fact that the platform upon the outer edge of which the Great Barrier Reef has grown, extends southward far beyond the latitude of corals, and Vaughan has observed that the platform of the Florida reef extends far northward beyond the last coral reefs. Also we may observe the Barrier Reef platform extends northward to the coast of New Guinea although the corals are killed in the wide region of the Bligh Entrance by the silt of the Fly and other great Papuan rivers. Thus it appears that the corals have merely grown as break-waters upon the seaward edges of platforms which were formed before the reefs themselves developed.

In some respects, the Pacific reefs are markedly different from those of the Atlantic. In the Pacific, one misses the beautiful sea fans and gorgonians that wave in languid grace to the rhythm of the surges in the crystal waters of Florida and the Bahamas. Instead, we find large areas of leathery-looking alcyonaria, or fleshy eight-rayed corals, *Sarcophyton* and *Alcyonium,* and in the crevices one often sees the giant clams *Tridacna,* their valves opened to show the beautiful mantle edges of malachite green, or blue, yellow or mottled with brown in a gamut of color, no two individuals being alike.

There are almost twice as many kinds of corals in the Pacific as in the Atlantic, and some of the more fragile of these grow luxuriantly down to depths of 60 feet or more, whereas in the Atlantic the coral reefs thrive well only in shallow water not over 20 feet in depth.

But the most striking feature which distinguishes the Pacific reefs is the development of a ridge which actually projects half a foot or more above low tide level and extends along the outer seaward edge of the reef-wall wherever the breakers dash. In the Paumotos, this ridge is dull reddish pink in color, and it is composed of a mass of stony seaweeds or nullipores of the sort called *Lithothamnion,* and also of

THE LITHOTHAMNION RIDGE ALONG THE SEAWARD FACE OF THE SOUTHEAST REEF OF MAËR ISLAND, MURRAY ISLANDS.

bryozoa which are remarkable lime-secreting organisms related more closely to the worms than to any other phylum of the animal kingdom.

This lithothamnion ridge thrives only where the breakers strike in full force upon its living barrier, and it serves as the chief protector of the island, breaking the force of every wave that approaches the windward shore.

Clustered in the tide pools of this lithothamnion ridge, with the waves dashing constantly over them one finds living corals which cling tenaciously to the shallow crevices and grow into thin encrusting forms instead of into dome-like shapes as in more protected waters; or their branches are remarkably short stump-like and gnarled and tend to bend inward toward the shore after the manner of the ragged trees that survive along a wind-swept coast.

At Maër Island, the lithothamnion ridge extends along the extreme outer edge of the southeastern reef between 1,800 and 2,200 feet from shore, and it forms a veritable dam which prevents the escape of the water from the basin of the reef-flat at the lowest tides, so that at the low tide of the springs, one finds here a great shallow marine lake about 1,700 feet wide, 2½ miles long, and only about 18 inches deep.

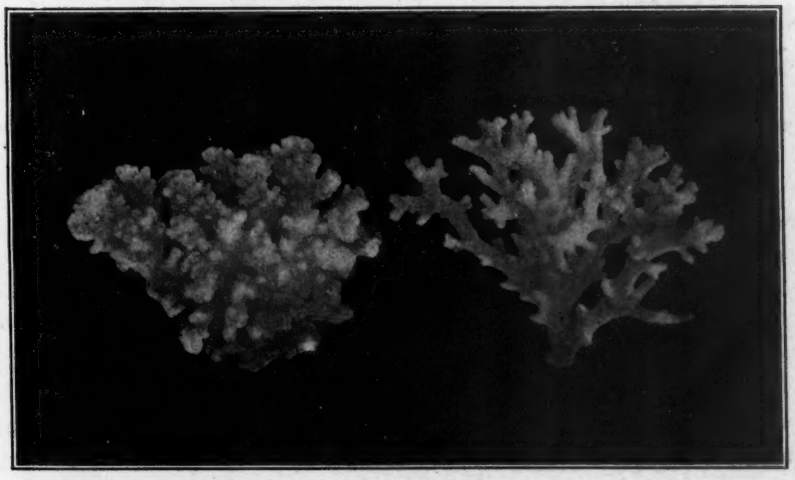
About 3,600,000 coral heads grow upon the hard rocky bottom of this natural aquarium, and in the middle region of the reef-flat, 1,000 feet from shore, fully 50 per cent. of the bottom is covered with heads the dominant species being the delicate and profusely branched *Seriatopora histrix* which forms a veritable coral forest, growing so luxuriantly that no other species can thrive so well in this region as it does nearer shore or farther out upon the reef. It is evident that there is a struggle for existence between the different sorts of corals, and the *Seriatopora*

wins in this strife for place in the region 1,000 feet from shore. It is, however, very sensitive to high temperature, and the warm shallows close to shore are fatal to it so it can not survive within 550 feet of the beach. Also, being very slender, it can not survive the rush of the breakers and, thus it disappears about 1,670 feet out from shore where the surges shatter its fragile stems. Delicate and sensitive to high temperature, to silting, and to agitated water as it is, however, if conditions be ideal for its existence, it thrives so well that all other corals, even those that can live anywhere over the reef-flat, must give way to it.

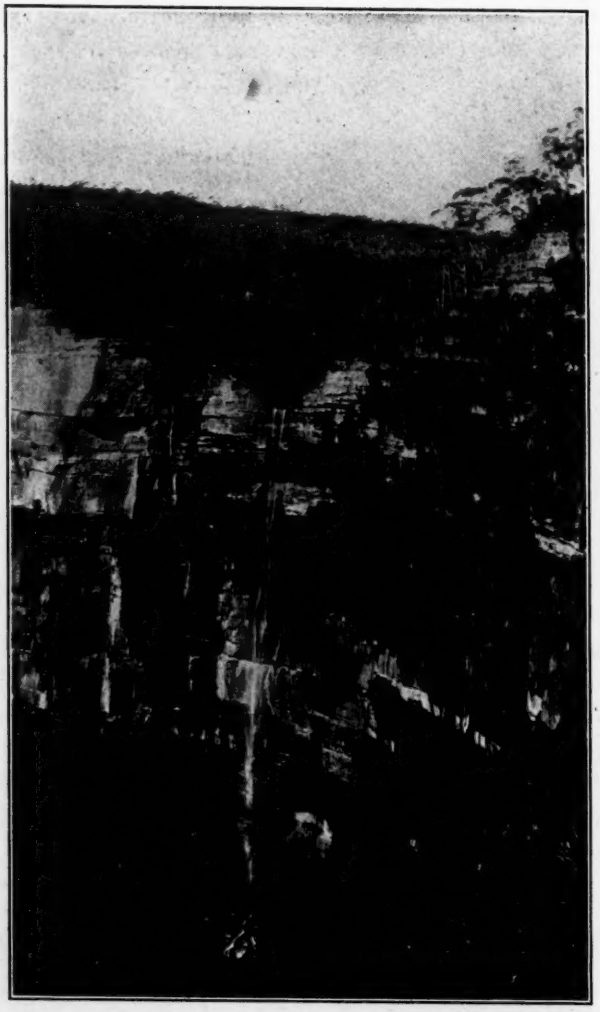
The amount of food required to support the vast coral population of this reef-flat must be very great, especially, as Dr. Vaughan discovered, corals are strictly carnivorous and will not even attempt to capture plants. The minute floating animal life of the ocean is therefore the chief source of food for corals. Moreover, Dr. Vaughan showed that it is possible at a glance to tell the difference between a fat-looking, well-fed coral and the thin, drawn appearance of a starved one. The corals of the southeast reef of Maër Island, however, all seem to be well fed, and thus it appears that the question of food has little or nothing to do with their struggle for existence.

There are, however, no large heads upon this reef, only a vast array of small ones.

Now the Murray Islands are in a fortunate region which is never visited by hurricanes, and thus the corals grow on for ages undisturbed by severe storms. Along the entire southeast beach only two small coral heads were found tossed ashore by the waves, a striking fact in contrast with the great heaps of dead coral ten feet high, found strewn along the shores of the Paumotos Islands where severe hurricanes occur.



Pocillopora damicornis. The fragile specimen on the right grew in the calm waters of the reef flat. The rigid one on the left grew in a tide pool among the breakers. Murray Islands, Torres Straits.



BRIDAL VEIL FALLS, GAVETT'S LEAP, in the Blue Mountains of New South Wales, showing the characteristic block faulting seen along this part of the Australian coast.

There are, however, parts of the Great Barrier Reef region which are afflicted periodically by hurricanes and the reefs in these regions consist of *large* coral heads quite *far apart* instead of great numbers of small ones close together. Moreover, the pure ocean water of the Murray Islands is fairly free from silt, whereas that of Thursday Island bears a vast amount of mud in suspension and this, also, is fatal to corals and buries the small heads more readily than the large, and thus the reefs of Thursday Island are not rich, but the coral heads are of large size and are widely separated.

It is interesting to see how the 40 or more species of corals that grow

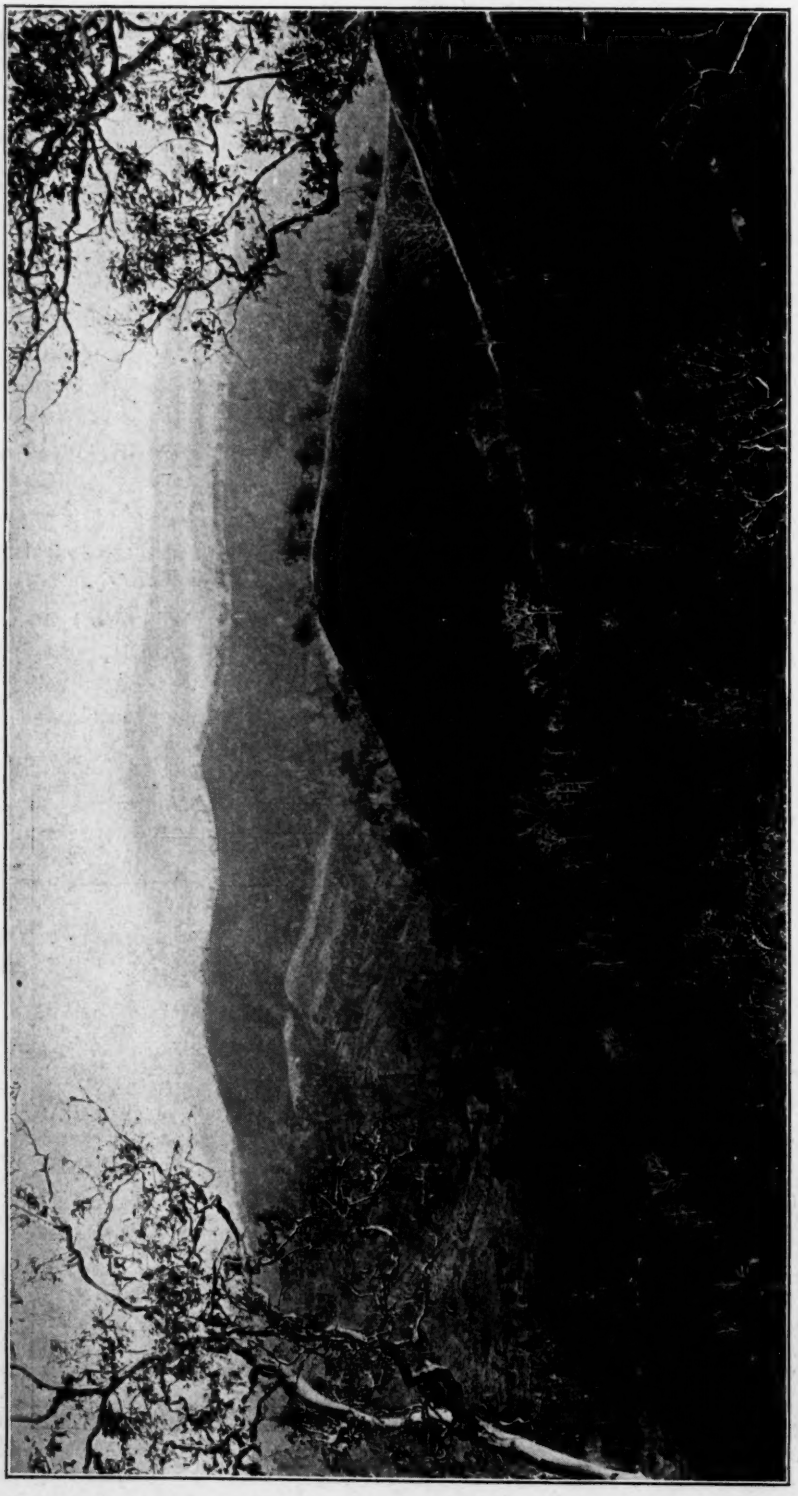
upon the southeast reef-flat are distributed, and in order to gather a census of the corals, a line was surveyed across the reef, and at intervals of 200 feet, squares of 50 feet on the side were staked off and all the coral heads on each square were counted.

The shallows within 350 feet of the shore lack corals, the bottom being covered with a thin layer of limestone mud which supports a vigorous growth of a short-bladed eel grass, *Posidonia australis.*

On the square whose center was 400 feet from shore, only three small coral heads were found, and these were growing upon loose corroded limestone blocks which had been washed shoreward from the outer parts of the reef-flat. As one goes outward, however, the coral heads steadily increase in number becoming a maximum at 1,425 feet from shore where there were 1,838 coral heads on the square. Even the crest of the lithothamnion ridge 1,750 feet from shore had 201 living coral heads clinging to the bottom of its shallow tide pools, although the ridge itself was here fully six inches above the level of the lowest tides.

There must be some cause for this tendency on the part of the corals to grow best at considerable distances from shore. The truth of the matter is that corals are very sensitive to changes of temperature and an ocean as cold as 56° or as warm as 98° F. would be fatal to all the reef-building forms. The more delicate corals such as the finely-branching *Seriatopora* or the "stag horns," formerly known as *Madre-*

PORT MORESBY, PAPUA, showing the drowned character of the coast.



THE INTERIOR OF NEW GUINEA FROM THE SHORE RIDGE ABOVE PORT MORESBY, showing the lines of mountain ranges running parallel with the coast.

pora but now called *Acropora,* are killed at 97.5°, and cease to take food at about 90.5°, while the more resistant forms such as various species of *Siderastrea,* and *Porites* and some of the brain corals, survive to 100°, or even 102° F., but cease to feed at from 95° to 97.5° F. Now, in general, those corals which are most sensitive to high temperature are correspondingly so to the smothering effects of silt. The more delicate forms such as *Acropora, Pocillopora* and *Seriatopora* are killed by being buried for only 10 to 14 hours beneath the mud, whereas, those corals which die at 100° can withstand as much as 40 to 50 hours of burial and *Siderastrea radians* of the Atlantic, which dies at 102°, can survive being buried 72 hours without apparent injury. It seems, therefore, that high temperature may produce death by causing asphyxiation, and thus those corals which can withstand the highest temperature are usually those which are best able to resist being covered by mud and silt, and these are the very corals which live in the hot, muddy shallows near the shore, while corals which require pure water live far out upon the reef, where the temperature is lower.

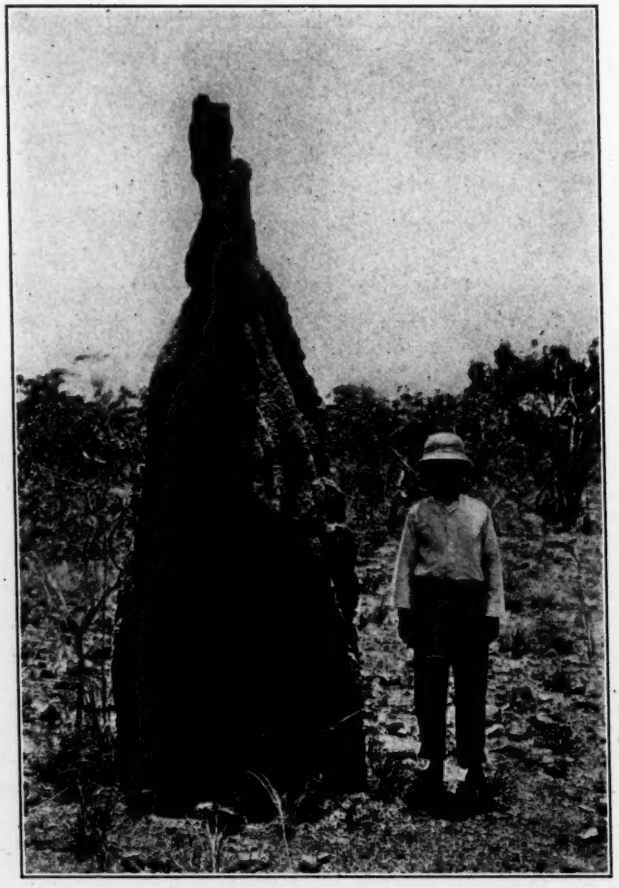
It will be recalled that Winterstein who studied frogs decided that the nervous paralysis that results from high temperature was caused by asphyxiation; but later Babàk, and Amerling showed that some of the frogs and toads are very resistant to lack of oxygen but easily paralyzed by heat, while the reverse is the case with others. Becht also casts doubt upon the asphyxiation theory by showing that recovery from heat paralysis can take place in the absence of oxygen in the water surrounding the nerves of the frog or of the horse-shoe crab (*Limulus*). Oxygen may however have been derived from the tissues themselves.

Among corals we find that *Favia fragum* and *Mœandra areolata* are more resistant to the effects of CO_2 or of silt than one would expect from their death temperatures, which are fairly low. If however they be buried in the sand and then heated they are still nearly as resistant as if in the open water, whereas sensitive corals such as *Acropora* or *Orbicella* are killed at lower temperatures if buried than if heated in the open water.

The explanation may be that *Favia* and *M. areolata* can survive at a low as well as at a high rate of metabolism, in other words "hibernate" under the mud; and thus be almost as well able to resist heat in this condition as when living at a higher rate of oxygen-consumption in the free water of the ocean.

We still incline to the belief, therefore, that high temperature may produce death in corals by asphyxiation, although other factors may complicate the matter, as is so often the case in physiological reactions.

Vaughan, indeed, has shown that those corals which live in muddy regions are quite able to free themselves from silt by means of the cilia which cover their surfaces, but those forms which live in the pure water of the outer parts of the reef are not so efficient in this respect.

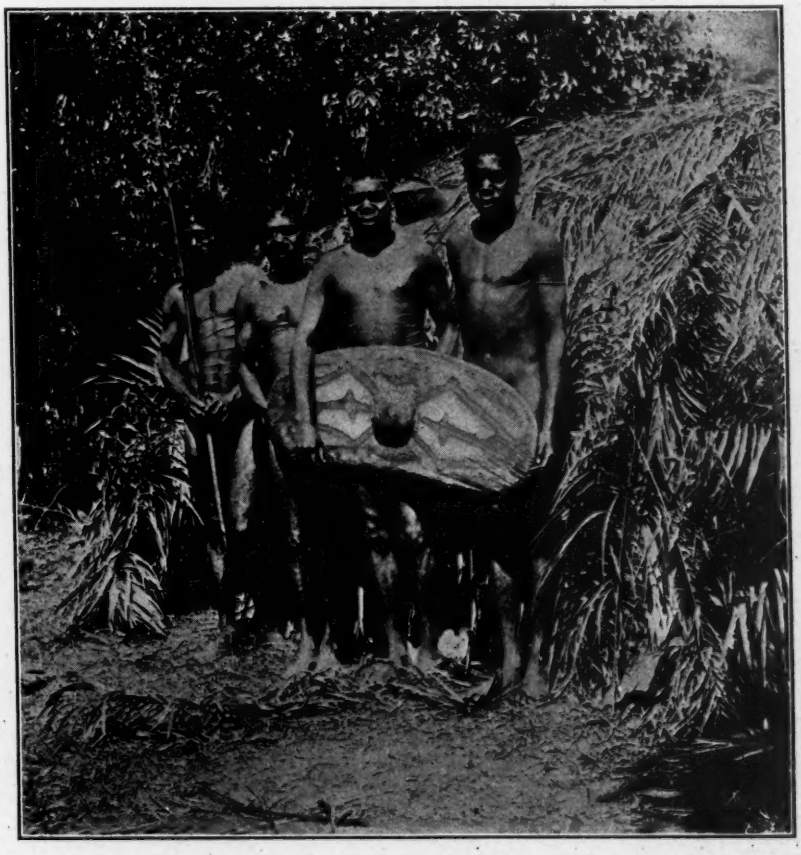


TERMITE'S NEST, PRINCE OF WALES ISLAND, TORRES STRAITS.

We saw that there is evidence of a struggle for existence between the various kinds of corals, and according to Darwin's theory, we would expect this to have improved the corals. The Australian forms must withstand a very high temperature during the calm, hot days of the "northwest" season, while those of Florida must suffer annually from cold "northers." Yet, our experiments show that the Australian corals are quite as sensitive to high temperature as are those of Florida, and conversely the Florida corals can not withstand cold any better than can those of tropical Australia. In other words, natural selection has not improved the heat-resisting or cold-withstanding powers of the corals and yet temperature is a factor of primary importance in determining the life or death of reef corals. Of late years we have been steadily losing respect for the efficacy of natural selection as a means of developing morphological or physiological adjustments.

We must conclude that "corals are corals," and their behavior is essentially alike both in Florida and in Australia.

As we have seen, the "lagoon" of the reef flat on the southeast side of Maër Island is shallow, being only about 18 inches deep at the lowest tide, although covered by about 8 feet of water at high tide. When the low tide falls at the hottest part of the day, at about 3 o'clock in the afternoon, the water of the reef flat is several degrees warmer than the air, but in the early morning before sunrise, the water is always colder than the air. This shows that the lagoon water derives most of its heat during the day from direct solar radiation, and at night the surface of the water radiates heat into outer space and thus becomes colder than the air. It has been commonly supposed that the temperature range of ocean water is less than that of the air, but this is evidently not the case in shallow lagoons in the tropics where the range in air temperature is slight. Indeed, during five weeks in September and October at the Murray Islands, the difference in air temperature between the hottest day and coolest night was only 10° F., the hottest being 86° and the coolest 76°; but during the same time the water over the southeast reef-



NATIVES OF KURANDA, QUEENSLAND, standing in front of their house. Australian aborigines.

flat ranged through 21°; the hottest being 93° and the coolest 72° F. Thus the reef-flat corals must be able to withstand a considerable range in temperature.

In the Pacific, the lithothamnion ridge always grows along the seaward face of reefs, provided the reef is exposed to the breakers, for the lithothamnion can thrive only in strongly agitated water. This ridge at Maër Island is only about six inches above low tide, for the breakers are not very high, the force of the rollers being partially spent upon the reefs of the Great Barrier six miles to the eastward of the Murray Islands.

We saw that at low tide the southeast reef flat of Maër Island is a wide shallow lake dammed in by the lithothamnion ridge. Now as the reef grew seaward this lithothamnion ridge always remained as a narrow boundary wall upon its advancing edge.

Thus in former times when the reefs began to grow outward, the lithothamnion ridge must have been close to the shore, whereas now it is from 1,800 to 2,200 feet out to sea. The lagoon behind this ridge is about eighteen inches deep and it is evident that as the reef advanced outward the shoreward edge of the lithothamnion ridge must have disintegrated or dissolved and has thus disappeared. Indeed, the disintegration of the dead inner edge of the lithothamnion ridge is very apparent in its ragged outline and the many loose blocks which are detached from it and washed shoreward, the process of disintegration being accelerated by the boring of numerous echinoderms; and it is evident that in same manner, a thickness of about two feet of limestone has disappeared so that the bottom of the present lagoon is now about eighteen inches below the crest of the lithothamnion ridge.

Sir John Murray and Alexander Agassiz believed that limestone was dissolved by sea water, but Dr. T. Wayland Vaughan collected samples of water from the lagoon of Tortugas, Florida, for an entire month and these were analyzed by Mr. R. B. Dole, who decided that they contained no free carbon dioxide. Now, without carbonic acid, or some other free acid, sea-water can not dissolve limestone.

The Tortugas is peculiar in being surrounded by wide areas of chalky mud and, moreover, the surface waters of the Florida-Bahama contain, according to Drew and Kellerman, great numbers of bacilli which cause a precipitation of calcium carbonate composed of such minute colloidal particles that they float for some time before sinking to form the impalpable limestone ooze of the sea bottom, and, finally, to change into oolite in the manner explained by Linck and by Vaughan, oolite being a rock composed of small calcium carbonate balls causing it to resemble fish roe.

One might expect therefore that the excessive amount of calcium carbonate in the water would hold the carbon dioxide in chemical combination, but Dr. Shiro Tashiro working with his marvelously sensitive

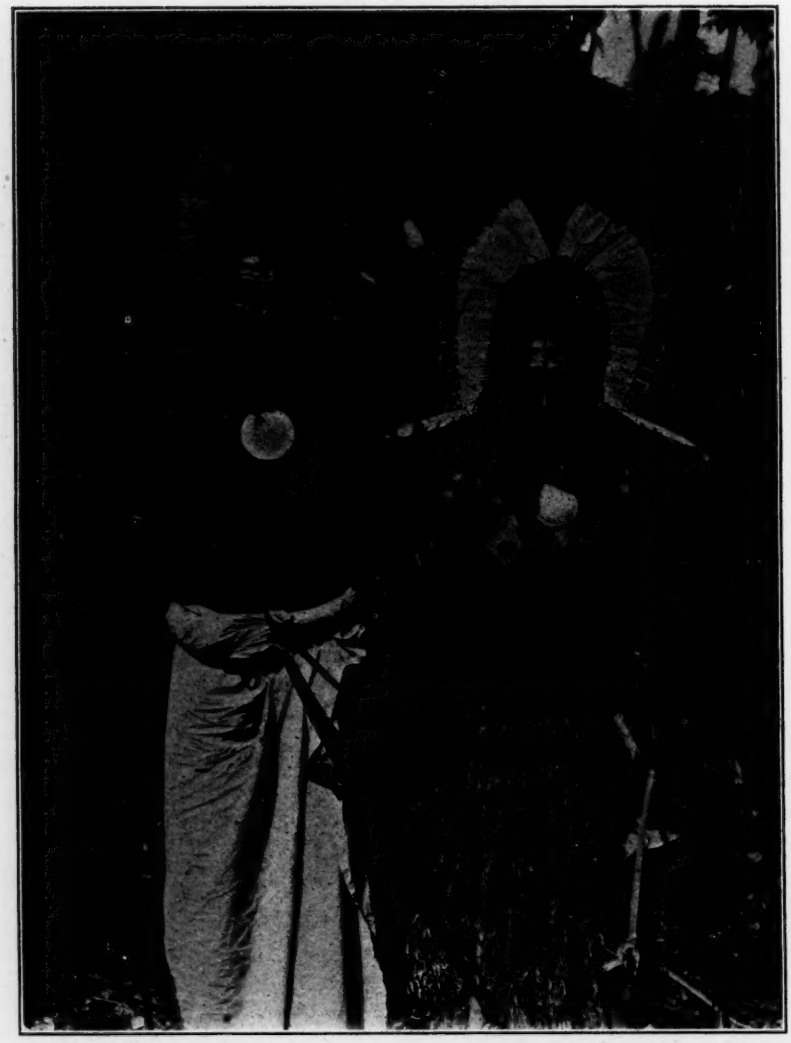
bromites, finds that carbon dioxide is set free, and discharged into the air, from the Tortugas sea-water at ordinary atmospheric pressures and temperatures. The whole question as to the condition of the carbon dioxide within the ocean itself is therefore thrown open to be determined by future researches. It is still possible, however, that the sea-water of Florida can not dissolve limestone and if this be true, the lagoons of the Florida-Bahama region were not formed by marine solution; but as yet no direct tests have been made to determine the efficacy of the water of the reefs as a limestone solvent, although the writer has begun a series of experiments to test this at Tortugas.

It seems that the limestone of the shallow southeast reef-flat of Maër Island must dissolve, for the disintegrated coral sand disappears *in situ*, there being very little sand either on the hard, rocky bottom of the lagoon or on the beach.

There are, however, several factors other than sea-water which might cause such solution, for it is well known that when rain-water percolates through dead leaves it gains a considerable charge of carbonic acid and this has been the cause of the solution which has resulted in the formation of the numerous caverns seen in all limestone regions. It is evident that the torrential rains of the wet season at Maër Island cause a great outpouring of fresh water from the shores over the reef flat and this must dissolve the limestone. This is not necessarily injurious to the living corals, however, for experiments made at Maër Island show that all species can survive being in sea-water diluted with an equal volume of rain-water for at least four and a half hours, and most of the forms can survive twelve hours of such treatment. The fact that there is but little coral sand along the southeast beach indicates that after it is cast ashore it is soon dissolved by the terrestrial drainage in the wet season.

There are, also, other agencies which dissolve limestone, for Professor Treadwell finds that worms which form burrows in dead coral heads are decidedly acid, and many sponges and boring plants are well known to dissolve the shells of molluscs. In addition, Stanley Gardiner, Wood-Jones, and others have observed that echinoderms which swallow large amounts of calcareous sand probably dissolve a certain percentage of it in their digestive tracts. We thus see that limestone is built up by some agencies and destroyed by others and the resultant condition of the reefs represents the balance between these antagonistic tendencies.

This leads us to the question of the rate of growth of corals, a subject which has been studied in greatest detail by Dr. Vaughan at Tortugas, Florida, and in the Bahamas, but upon which many other students have worked in a less exhaustive manner. For example, in 1890, Saville-Kent measured and photographed certain corals off Vivien Point, Thursday Island, and some of these we succeeded in identifying and remeasuring in November, 1913, and it appeared that a brain coral, *Symphyllia*, which



NATIVES OF THE MURRAY ISLANDS, TORRES STRAITS, WEARING "DARIS." Papuans of the Fly River Delta type.

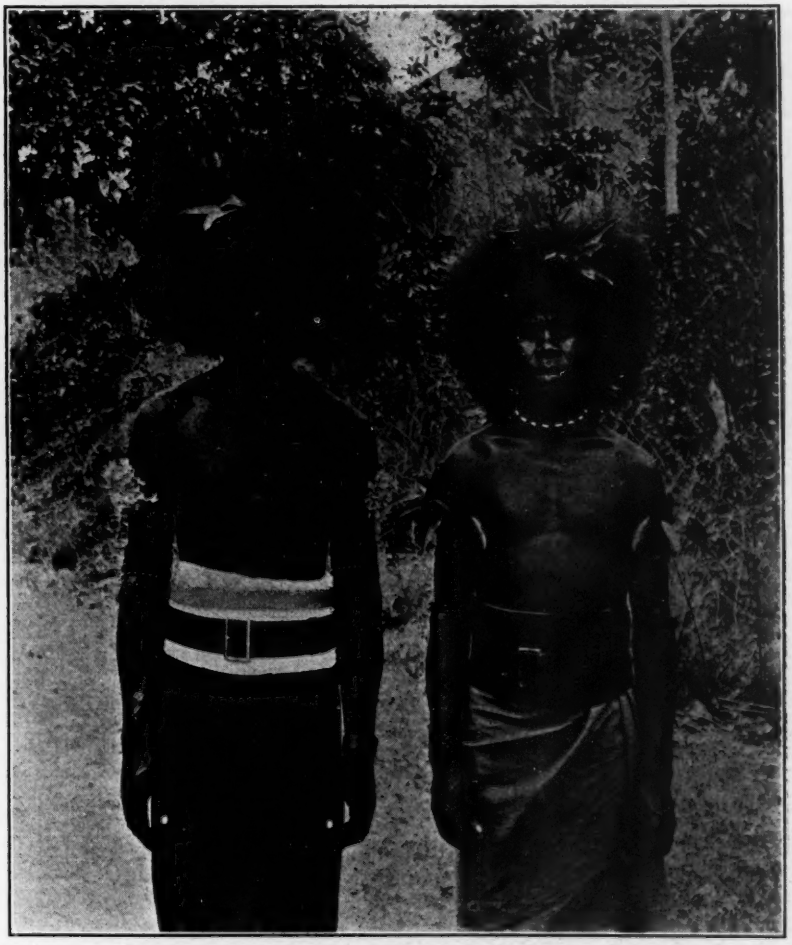
was 30 inches in diameter in 1890 had increased to be 74 inches in 1913. Also, a huge coral which Saville-Kent called "*Porites astræoides*" was 19 feet in diameter in 1890 and 22 feet and 9½ inches in 1913. On the other hand, a certain gray-green *Goniastrea,* which was 8 feet, 2 inches wide in 1890 had not grown during the intervening 23 years. Indeed, Dr. Vaughan's growth experiments upon Florida corals show that perhaps all corals grow to well-defined sizes and then cease to enlarge. However, the corals that did grow at Vivien Point had increased in diameter from 44 to 45½ inches in 23 years, or about 1.9 inches per annum.

Thus charts of channels which are only occasionally used, and the

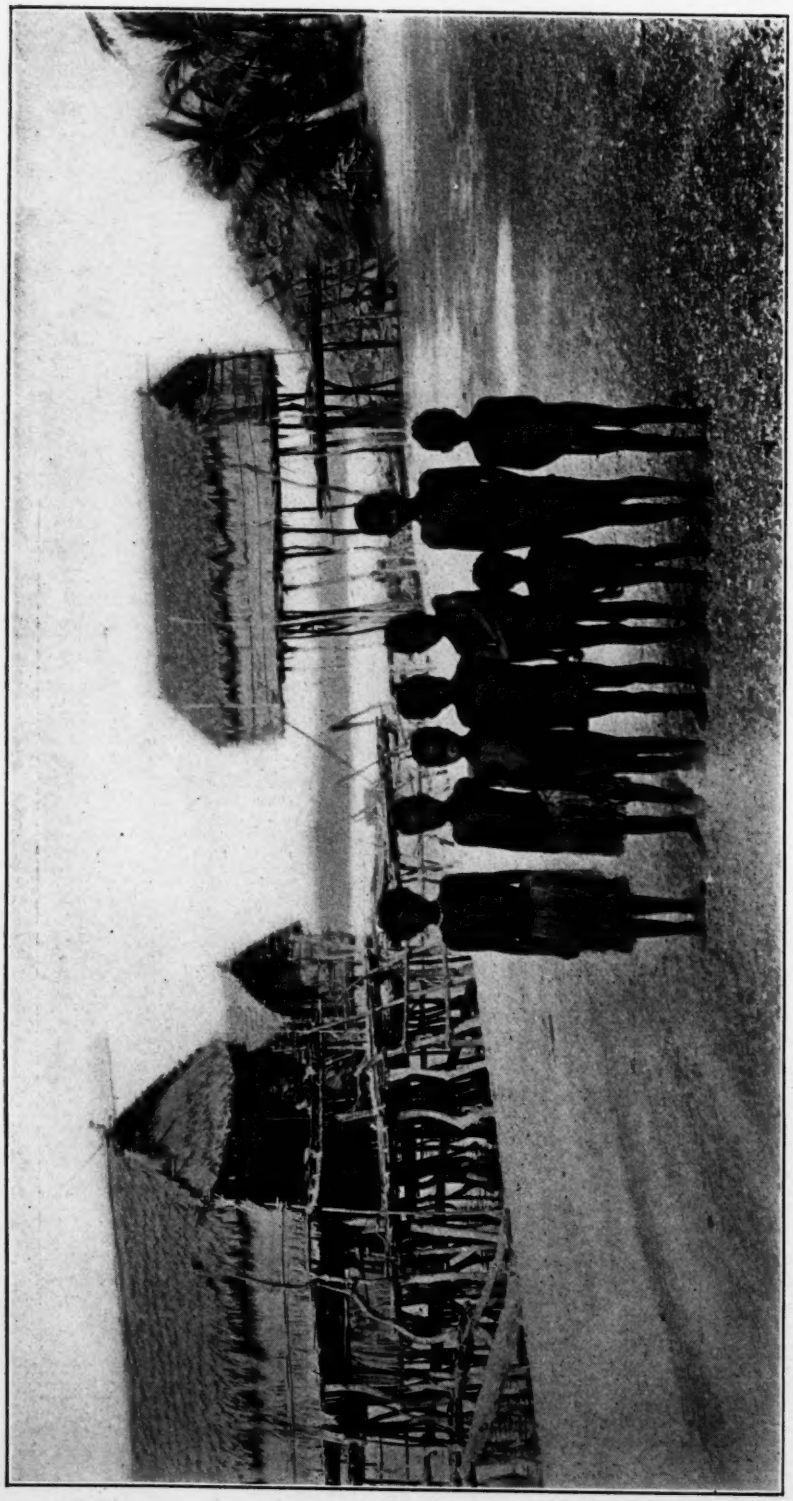
bottoms of which are covered with corals, should state that an upward growth of at least one inch per annum may be expected.

But other studies apart from those upon coral reefs were conducted at the Murray Islands. Dr. Hubert Lyman Clark, of Harvard, found many species of the delicate feathery "sea lilies" or crinoids, which live among the coral heads below low tide. These crinoids were, by some, supposed to be sedentary animals but Dr. Clark found that at least certain forms can swim actively through the water using their long graceful arms as oars. In cretaceous times crinoids were abundant along our own shores but are now common only in the depths of the Atlantic Ocean and in the shallow water of the western tropical Pacific and Malayan region northward to Japan.

There were also great numbers of slender serpent stars, rapidly moving forms which usually live in crevices among the rocks and scuttle off



GOVERNOR MURRAY'S SERVANTS. Natives of Port Moresby, Papua. Types of the natives of the S.E. coast of New Guinea.



HANUABADA VILLAGE, PORT MORESBY, PAPUA. The flimsy nature of the buildings illustrates the immunity of the region from hurricanes.

with great rapidity when disturbed. They are often called "brittle stars," for if one seizes an arm it is promptly cast off, permitting the major portion of the animal to escape. Their beautiful sculpturing, rich colors, and the ornate patterns of their disks were admirably figured in color by Mr. E. M. Grosse, who executed more than 100 beautiful drawings which will serve to illustrate Dr. Clark's purposed paper upon the Echinoderms of Torres Straits. Indeed, Dr. Clark aptly called the region "a paradise for echinoderms," and it appears to be the richest known locality in the world for shallow-water forms of these animals, for Dr. Clark found 51 species at Maër Island alone, and in addition, he collected 26 others at Badu, Darnley and Thursday Islands; making 177 from Torres Straits. Thus his collection is a notable addition to that of the Museum of Comparative Zoology at Harvard, which was probably already the greatest gathering of specimens of echinoderms in the world. In almost every instance Mr. Grosse's figure is the only colored drawing of these Torres Straits species, and thus Dr. Clark's paper will be a classic upon the subject of tropical Pacific echinoderms.

117 species had been previously recorded from Torres Straits, and of these, Dr. Clark found only 42, but in addition he found at least 45 not previously known to science, so that at present fully 250 echinoderms are known from this extraordinary region.

As is well known to physiologists, the important subject of the penetration of living cells by alkalies has for several years engaged the attention of Dr. E. Newton Harvey, of Princeton, and his results essentially support Overton's lipoid theory, namely, that those substances which are most readily dissolved in fat-solvents enter living cells most readily; and this leads one to suspect that the cell surface may be lipoid, or fat-like in nature.

No one had been able to test this hypothesis for acids, until Dr. Harvey discovered a holothurian at the Murray Islands, *Stycopus ananas,* the intestines of which are purplish-red. If placed in acid, however, they turn bright red, and in alkalies dark purple; and these changes are reversible and may take place in weak acids or alkalies without killing the cells. Dr. Harvey used 24 different kinds of acids in dilute solutions upon this animal and found that those which are most poisonous penetrate most rapidly, and all the acids penetrate about in the ratio of their degree of toxicity. There is, on the other hand, no relation between the degree of dissociation of an acid and its rate of penetration of the living cells; and there is only a fair but by no means perfect agreement between the rate of penetration and the solubility of an acid in xylol.

Overton's theory applies, however, with the majority of acids, but the agreement is not perfect, and hence Harvey concludes that the power of penetration of an acid depends not only on its lipoid solubility but

also upon the affinity of the acid for certain protein substances of the cell surface.

Mr. Frank A. Potts, of Trinity Hall, Cambridge University, reports that he found at the Murray Islands a small lobster-shaped crustacean called *Alpheus* which lives among the arms of crinoids and usually resembles the rich brown or mottled color of its host. Upon examining some of these *Alpheus,* Mr. Potts noticed numerous small pink sac-like bodies attached to their legs and these sacs contain the eggs and young larvæ of a barnacle-like animal which is evidently a parasite infesting the *Alpheus.* In fact this degenerate barnacle grows within the tissues of the *Alpheus,* and losing all semblance to a crustacean, changes into a mass of root-shaped branches which at intervals send out sac-like genital organs, these being the only special organs it possesses. When the *Alpheus* moults, the sacs are cast off and each little larva is doubtless liberated to wander for a time as a free-swimming minute crustacean and finally to find an *Alpheus* and to enter its body and change into a root-like parasite, losing its eyes, legs, antennules, and all organs of special sense to grow into a mere root-like form which sends out its genital sacs upon the legs of its unfortunate host. The name of this very degenerate creature is *Thylacoplethus.*

Another curious animal which attracted the attention of Mr. Potts was a crab called *Hapalocarcinus,* the female of which settles down while still very small and immature among the branches of the *Pocillopora* coral. Here the breathing of the crab produces a water current and this causes the branches of the coral to thicken and finally to enclose the crab in a capsule, leaving only a small aperture far too small to permit of its escape, but large enough to admit the minute male of the species who visits the chamber at the time the female moults.

Professor David Hilt Tennent, of Bryn Mawr College, while at the Tortugas Laboratory in Florida, discovered that the hybrid larvæ of certain echini can be caused to resemble either their father or their mother in response to definite changes in the alkalinity of the seawater. The cytology of this matter has attracted much attention and discussion, and Professor Tennent went with us to the Murray Islands to continue studies of similar import and to study other hybrid crosses between echinoderms.

He caused an artificial cross to occur between a crinoid and an echinus and carried the larvæ farther than had previously been done.

Some of Professor Tennent's best studies were carried out upon Badu Island where members of the expedition enjoyed the privilege of being the guests of the Reverend F. W. Walker, the able managing director of the "Papuan Industries, Limited," which is devoted to developing arts and crafts among the natives thus to enable them to become self-supporting in the broad civilized sense of the term, and to

restore that self respect and interest in life which the too sudden introduction of civilization has in large measure crushed out among them. Interesting and hopeful results are being achieved by this sociological, rather than purely religious, enterprise. The natives must first learn how to earn a living before they can make any real advance in the development of a moral and social standard to which they can hold as things of their own initiation. At present a mere semblance of civilization has been forced upon them from outside, but a race to survive must be the father of its own ideals.

After leaving the Murray Islands, Mr. Potts and the leader of the expedition went to Port Moresby, Papua, where His Excellency, the Honorable John H. P. Murray, the governor, was so kind as to invite us to be his guests at Government House during the entire period of our visit.

The English deserve the greatest credit for the altruistic government which is being administered to benefit and uplift the native population. "Fair play for the Papuan" is the watch-word of the colony.

Malaria is still the dreaded pestilence of Papua, and for generations yet to come many noble English lives must be extinguished by its ravages, but despite the dull heat, the certainty of ennervating illness, and the vast areas yet unknown to any save the savage in the stone age, this little band of high-minded men has not lost heart but year by year intertribal wars, cannibalism and sorcery are becoming things of the past, and the natives are slowly but willingly acquiring their first lessons in civilization.

Without detracting from the honor due the missionary who leaves home and friends and seeks the degraded places of the earth, let us not forget the equally altruistic civil servant whose hardships and dangers and devotion to duty we are all too apt to belittle or overlook, yet whose service though less conspicuous than that of his religious coworker is equally significant for the raising of England's standard of freedom before the eyes of the whole earth.

THE CELLULAR BASIS OF HEREDITY AND DEVELOPMENT. II

By Professor EDWIN GRANT CONKLIN
PRINCETON UNIVERSITY

C. The Mechanism of Heredity

The mechanism of heredity, as contrasted with the mechanism of development, consists in the formation of particular kinds of germ cells and in the union of certain of these cells in fertilization. We have briefly traced the origin, maturation and union of male and female sex cells in a number of animals, and in these phenomena we have the mechanism of the hereditary continuity between successive generations. But in addition to these specific facts there are certain general considerations which need to be emphasized.

I. *The Specificity of Germ Cells*

The conclusion is inevitable that the germ cells of different species and even those of different individuals are not all alike. Every individual difference between organisms must be due to one or more differentiating causes or factors. Specific results come only from specific causes. These causes may be found in the organization of the germ cells or in environmental stimuli, *i. e.*, they may be intrinsic or extrinsic, but as a matter of fact experience has shown that they are generally intrinsic in the germ. In the same environment one egg becomes a chicken and another a duck; one becomes a frog, and another a fish, and another a snail; one becomes a black guinea-pig and another a white one; one becomes a male and another a female; one gives rise to a tall man and another to a short man, etc. Since these differences may occur in the same environment they must be due to differences in the germ cells concerned.

On the other hand, different environmental conditions may he associated with similar developmental results. Loeb and others have found that artificial parthenogenesis may be induced by a great variety of environmental stimuli, viz., by salt solutions, by acids and alkalies, by fatty acids and fat solvents, by alkaloids and cyanides, by blood serum and sperm extract, by heat and cold, by agitation and electric current. There is certainly nothing specific in these different stimuli. Similarly, Stockard has discovered that cyclopia, or one-eyed monsters, may be produced by magnesium salts, alcohol, chloretone, chloroform, and ether. In all such cases it is evident that the specific results of such treatment

are due to a specific organization of the germ rather than to specific stimuli.

Why does one egg give rise to a chicken and another to a duck, or a fish, or a frog? Why does one egg give rise to a black guinea-pig and another to a white one, though both may be produced by the same parents? Why does one child differ from another in the same family? Why does one cell give rise to a gland and another to a nerve, one to an egg and another to a sperm? If these differences are not due to environmental causes, and the evidence shows that they are not, they must be due to differences in the structures and functions of the cells concerned.

Many differences in the material substances of cells are visible, and many more are invisible though still demonstrable. These differences may not be detectable by chemical or physical tests, and yet they may be demonstrated physiologically and developmentally. The most delicate of all tests are physiological, as is shown by the Widal test in typhoid fever, the Wassermann reaction in syphilis, the reactions of immunized animals to different toxines, etc. Lillie has recently shown that egg cells give off a substance which he calls *fertilizin,* which can be detected only by the way in which spermatozoa react to it. No chemical or physical test can distinguish between the different eggs or spermatozoa produced by the same individual, but the reactions of these cells in development prove that they are different. Undoubtedly chemical and physical differences are here present, but no chemical methods at present available are sufficiently delicate to detect them. The developmental test proves that there must be as many kinds of germs as there are different kinds of individuals which come from germs. It is one of the marvelous facts of biology that every individual which has been produced sexually is unique, the first and last of its identical kind, and although some of these individual differences are due to varying environment, others are evidently due to germinal differences, so that we must conclude that every fertilized egg cell differs in some respects from every other one.

But are there molecules and atoms enough in a tiny germ cell, such as a spermatozoon, to allow for all these differences? Miescher has shown that a molecule of albumin with 40 carbon atoms may have as many as one billion stereoisomers, and in protoplasm there are many kinds of albumin and proteins, some with probably more than 700 carbon atoms. In such a complex substance as protoplasm the possible variations in molecular constitution must be well-nigh infinite, and it can not be objected on this ground that it is chemically and physically impossible to have as many varieties of germ cells as there are different kinds of individuals in the world.

Even with regard to morphological elements which may be seen with the microscope it can be shown that an enormous number of permuta-

tions is possible. It seems probable, as Boveri has shown, that different chromosomes of the fertilized egg differ in hereditary potencies, and where the number of chromosomes is fairly large the number of possible combinations of these chromosomes in the germ cells becomes very great. In woman, where there are probably 48 chromosomes, and, after synapsis, 24 pairs of maternal and paternal ones, the possible number of permutations in the distribution of these chromosomes to the different egg cells would be $(2)^{24}$, or 16,777,036, and the possible number of different types of fertilized eggs or oosperms which could be produced by a single pair of parents would be $(16{,}777{,}036)^2$, or approximately three hundred thousand billions. But probably other things than chromosomes differ in different germ cells, and it is by no means certain that individual chromosomes are always composed of the same chromomeres, or units of the next smaller order, and in view of these possibilities it may well be that every human germ cell differs morphologically and physiologically from every other one, in short that every oosperm and every individual which develops from it is absolutely unique.

Indeed, the production of unique individuals seems to be the chief purpose and result of sexual reproduction. In a sexual reproduction the individual variations which occur are chiefly, if not entirely, due to environment, but in sexual reproduction they are also due to new combinations of hereditary elements. The particular germinal organization transmitted from one generation to the next depends upon, (*a*) The ancestral organization, (*b*) The particular character of the cell divisions by which the germ cells are formed, (*c*) The particular kinds of egg and sperm cells which combine in fertilization. The ancestral organization determines all the general characteristics of race, species, genus, order, phylum. It determines the possibilities and limitations of individual variations. Given a certain ancestral organization, the individual peculiarities of the germ cells are determined by the particular character of cell division by which the germ cells are formed, and the peculiarities of the individuals or persons which develop from these cells are determined in large part by the particular kinds of germ cells which unite in fertilization.

The behavior of chromosomes in maturation and fertilization is like the shuffle and deal of cards in a game, and apparently with the same object, namely, never to deal the same hand twice. To make this comparison more complete suppose that kings be discarded from the pack, leaving 48 cards of two colors, red and black, which we will compare to the 48 maternal and paternal chromosomes in the human oocyte; suppose that in the shuffling of these cards corresponding cards of the red and the black suits are temporarily stuck together so that the ace of diamonds is united with the ace of clubs, the queen of hearts with the queen of spades, etc., thus forming 24 red-black pairs of the same

denominations. If these cards are then dealt into two hands, one card of each pair going to one hand and the other to the other hand, we will have two cards of each denomination in each hand, but if the cards are dealt indiscriminately some of them will be red and some black. This description parallels what takes place in the maturation of the human ovum, except that there is no evidence that there are more than two suits of chromosomes, one maternal and the other paternal.

To carry out this comparison in the case of the maturation of the human sperm where there are only 47 chromosomes it is necessary to take another pack and discard an additional card, say the queen of clubs; then in the union of corresponding red and black cards into pairs the queen of hearts unites with the queen of spades, but the queen of diamonds remains alone, and when the cards are dealt into two hands as before one hand will contain 24 cards and the other 23.

If now we complete this comparison by extending it to what takes place in fertilization we must take one hand from each of these deals and put them together into one pack; though this pack would contain cards of every denomination there would be varying numbers of red and black cards and a mixture of cards from two distinct packs. In no game of cards do corresponding cards from different packs have slightly different values nor are half of the cards taken from one pack and half from another (at every game), but this is just what happens in the shuffle and deal of the chromosomes. Because of the mixture of chromosomes from distinct individuals in every generation, each of which has its own peculiar value, the game of heredity becomes vastly more complex than any game of cards.

This illustration may serve to make plain the fact that the purpose of maturation and fertilization is, in part, this shuffle and deal of the chromosomes, and its result is that every oosperm and every individual which develops from it is different from every other one.

This conception of the specificity of every germ cell, as well as of every developed individual, sets the whole problem of heredity and development in a clear light. The visible peculiarities of an adult become invisible as development is traced back to the germ, but they do not wholly cease to exist. Similarly, the multidinous complexities of an adult fade out of view as development is traced to its earliest stages, but it is probable that they are not wholly lost. In short, the specificity of the germ applies not merely to those things in which it differs from other germs, but also to characters in which it resembles others—in short, to hereditary resemblances no less than to hereditary differences.

The mistake of preformation was in supposing that germinal parts were of the same kind as adult parts; the mistake of epigenesis was in maintaining the lack of specific parts in the germ. The development of every animal and plant consists in the transformation of the specific characters of the germ into those of the adult, but not in the formation

of structures or characters *de novo*. From beginning to end development in a series of morphological and physiological changes, but not of new formations or creations. It is only the incompleteness of our knowledge of development which allows us to say that the eye or ear or brain begin to form in this or that stage. They become visible at certain stages, but their real beginnings are indefinitely remote.

II. *Correlations Between Germinal and Somatic Organization*

All the world knows that the organization of the germ is not the same as that of the developed animal which comes from it, and yet the specificity of the germ indicates that there must be some correlation between the germinal and the developed organization—in short, there is not identity of organization, but correlation of organization between the germ and the adult. What correlations are known to exist between the oosperm and the developed animal?

1. *Nuclear Correlations*

Many biologists maintain that the nucleus and more particularly the chromosomes are the exclusive seat of the "inheritance material" and that all the "determiners" of adult characters are located in them.

There are certain general and *a priori* reasons for assuming that the chromosomes are important factors in heredity and differentiation; (1) they come in approximately equal numbers from the father and the mother, (2) one half of each of the maternal and paternal chromosomes is distributed to each cell of the developing organism, (3) in the formation of the egg and sperm cells the normal number of chromosomes is reduced by one half, and (4) in fertilization the normal number is restored by the union of the chromosomes of the egg and sperm. It is a remarkable fact that the determiners or factors of certain inherited characters come in equal numbers from both parents and that in spite of their ultimate association in an individual they may be separated or "segregated" in the formation of that individual's germ cells. Such inheritance is known as Mendelian and will be treated at length in the next lecture, but it may be said here that the association, distribution and segregation of Mendelian factors and of maternal and paternal chromosomes is exactly parallel. This is strong evidence that these factors are associated with the chromosomes.

There are also certain special reasons for considering that the chromosomes are important factors in heredity and development. (5) Boveri has studied the abnormal distribution of chromosomes to different cleavage cells in doubly fertilized sea-urchin eggs, and has found evidence that the hereditary value of different chromosomes is different.

(6) McClung, Stevens and Wilson have discovered that the determination of sex is associated with the presence or absence of a particular chromosome, the X-chromosome, in the spermatozoon which fertilizes

the egg. If an egg is fertilized by a sperm which lacks the X-chromosome a male is produced; if fertilized by the other type a female results. (7) Finally, Morgan has found that there is a linkage of certain somatic characters with sex in the fruit fly, *Drosophila,* which can be readily explained by assuming that the determiners for these characters are in some way associated with the sex chromosome.

We have in these facts a remarkable correlation between the distribution of the chromosomes and the occurrence of certain characters of the adult animal. The association of maternal and paternal chromosomes in fertilization and their segregation in the maturation of the germ cells is parallel to the association of Mendelian characters in the zygote and their segregation in the gametes; if the distribution of chromosomes in cleavage is abnormal the larva shows abnormal characters (Boveri); sex determination is associated with the distribution of a particular chromosome to one half of the spermatozoa, and the fertilization of the egg by one type or the other of spermatozoa (Wilson); the linkage of certain characters with sex finds a ready explanation by assuming that these characters are associated with the sex chromosome (Morgan).

2. *Cytoplasmic Correspondences*

On the other hand, the most direct and the earliest recognized correlations between the oosperm and the developed animal are found in the polarity and symmetry of the fertilized egg and of the animal to which it gives rise.

(*a*) *Polarity*

In all eggs there is a polar differentiation, one pole, at which the maturation divisions take place, being known as the animal pole, and the opposite one being known as the vegetative pole. The substance of the egg in the vicinity of the animal pole usually gives rise to the ectoderm, or outer cell layer of the embryo; the portion of the egg surrounding the vegetative pole usually becomies the endoderm or inner cell layer. The axis which connects these poles, the chief axis of the egg, becomes the gastrular axis of the embryo and in every great group of animals bears a constant relationship to the chief axis of the adult animal. The polarity of the developed animal is thus directly connected with the polarity of the egg from which it came (Figs. 23, 26, 29, 30, 40, 41).

(*b*) *Symmetry*

In many cases the symmetry of the developed animal is foreshadowed in the symmetry of the egg. The eggs of cephalopods (Fig. 40) and of insects (Fig. 41) are bilaterally symmetrical, while they are still in the ovary; in other cases, such as ascidians, amphioxus and the frog, bilateral symmetry appears immediately after fertilization (Fig. 29, 1, 2), though in some of these cases there is reason to believe that the

eggs are bilateral even before fertilization; in still other cases bilaterality does not become visible until later in development and we do not now know whether it is present in earlier stages or not; but wherever it can be recognized in the earlier stages it is certain that the bilateral

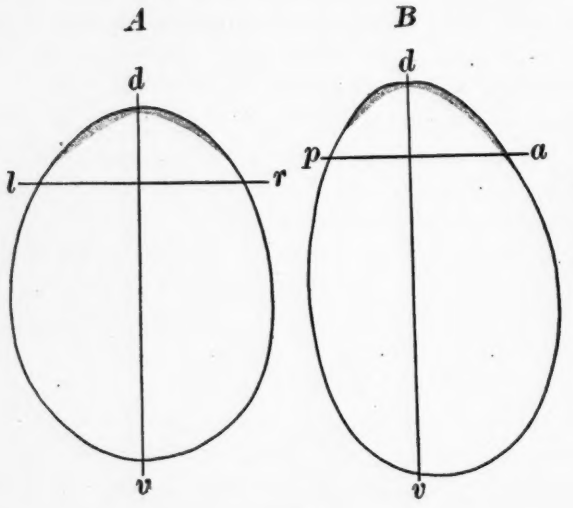


FIG. 40.

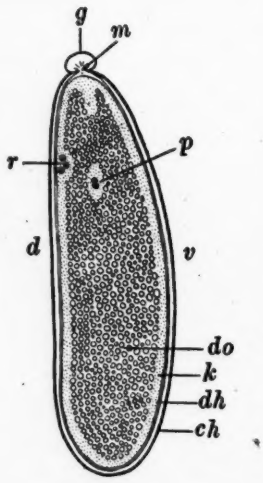


FIG. 41.

FIG. 40. OUTLINES OF THE UNFERTILIZED EGG OF A SQUID, *Loligo*, showing the polarity and symmetry of the egg with reference to the axes of the developed animal; *d*, dorsal; *v*, ventral; *l*, left; *r*, right; *a*, anterior; *p*, posterior. (After Watasé.)

FIG. 41. MEDIAN SECTION THROUGH EGG OF A FLY, *Musca*, just after fertilization, showing the relations of the polarity and symmetry of the egg to the axes of the developed animal; the long axis of the egg corresponds to the antero-posterior axis of the animal; *d*, dorsal; *v*, ventral; *m*, micropyle through which sperm enters the egg; *g*, glutinous cap over the micropyle; *r*, polar bodies; *p*, egg and sperm nuclei; *do*, yolk; *k*, peripheral layer of protoplasm; *dh*, vitteline membrane of egg; *ch*, chorion. (After Korschelt and Heider.)

symmetry of the egg bcomes the bilateral symmetry of the developed animal.

(*c*) *Inverse Symmetry*

In most animals bilateral symmetry is not perfect, certain organs being found on one side of the mid line and not on the other, or being larger or differently located on one side as compared with the other; among all such animals variations occasionally occur which show a complete reversal of these asymmetrical organs, *i. e.*, in man the heart and arch of the aorta may occur on the right side instead of the left, the pyloris and chief portion of the liver on the left instead of the right, etc. Among certain snails this inversion of symmetry may occur regularly in certain species and not in others, the inverse form being known as sinistral and the ordinary form as dextral (Fig. 44). In these sinistral snails, and probably in all animals showing inverse symmetry, the embryo is inversely symmetrical and every cleavage of the egg from the first to the last is the inverse of that which occurs in

dextral snails (Figs. 42, 43). There is good reason to believe that in such cases the unsegmented egg is also inversely symmetrical as compared with the more usual type (Fig. 42). In all of these cases there is a direct correspondence between the polarity and symmetry of the

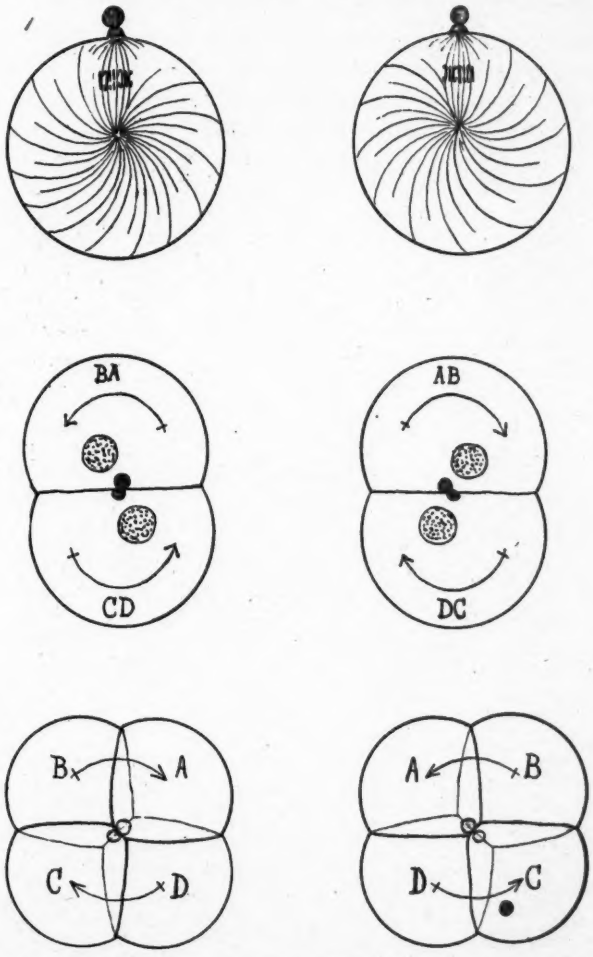


FIG 42. INVERSE SYMMETRY IN THE UNSEGMENTED EGG AND IN THE FIRST AND SECOND CLEAVAGES. Figs. 42, 43, 44. The cause of inverse symmetry in snails. In each case the right-hand column represents dextral forms, the left-hand column sinistral ones.

oosperm and the polarity and symmetry of the developed animal (Fig. 40–44).

(*d*) *Localization Pattern*

In many animals the ectoderm, endoderm and mesoderm may be traced back to areas of peculiar protoplasm in the oosperm, but in addition to this one can recognize in the ascidian egg areas of peculiar protoplasm which will give rise to mesenchyme, muscles, nervous system and notochord, and these substances are present in the oosperm in the

approximate positions and proportions which they will have in the embryo and larva (Figs. 28–31).

Indeed, there are types of localization of these cytoplasmic materials in the egg which are characteristic of certain phyla; thus there are the ctenophore, the flat-worm, the echinoderm, the annelid, mollusk and the chordate types of cytoplasmic localization (Fig. 45). The polarity, symmetry and pattern of a jelly fish, star-fish, worm, mollusk, insect or vertebrate are forshadowed by the characteristic polarity, symmetry and

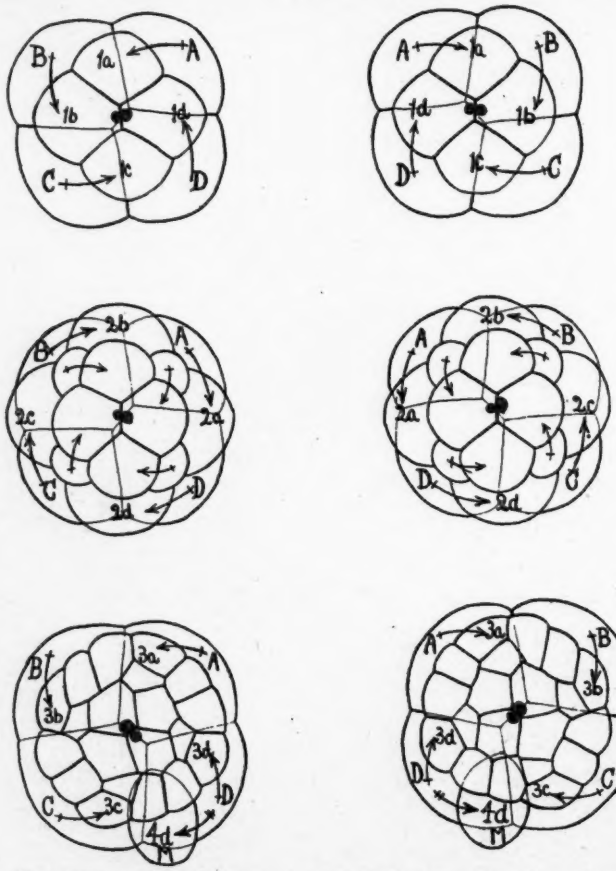


FIG. 43. INVERSE SYMMETRY OF THE 3D, 4TH, 5TH AND 6TH CLEAVAGES. The cells 1*a*–1*d*, 2*a*–2*d* and 3*a*–3*d* give rise to all the ectoderm; 4*d* or *M* gives rise to mesoderm; *A*, *B*, *C*, *D* to endoderm.

pattern of the cytoplasm of the egg either before or immediately after fertilization. In all of these phyla eggs may develop without fertilization, either by natural or by artificial parthenogenesis, and in such cases the characteristic polarity, symmetry and pattern of the adult are found in the cytoplasm of the egg just as if the latter had been fertilized. The conclusion seems to be justified that these earliest and most fundamental differentiations which distinguished the eggs of various phyla are not dependent upon the sperm.

All of these correspondences between the polarity, symmetry and pattern of the egg and of the developed animal are found in the cytoplasm. It is possible that the polarity may be carried over from generation to generation through the egg cell, but the symmetry and localization

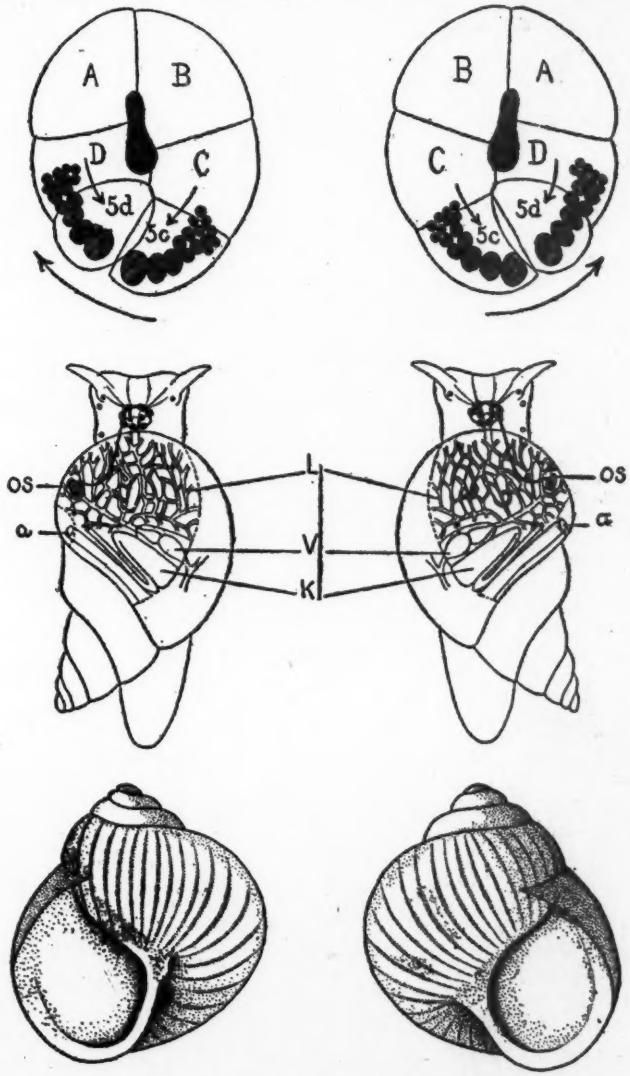


FIG. 44. INVERSE SYMMETRY IN LATE EMBRYOS AND ADULT STAGES. In 1, cross hatched area is blastopore; cells shaded by lines mesoderm, other cells endoderm; the spiral twist of the snail begins in opposite directions in the two embryos. In 2 the adult organization is shown with all organs inversely symmetrical; *os*, olfactory organ; *a*, anus; *L*, lung; *V*, ventricle; *K*, kidney. In 3 sinistral and dextral shells of adult snails are shown.

pattern develop in the ovum before or just after maturation. In this differentiation and localization of the egg cytoplasm it is probable that

certain influences have come from the nucleus of the egg, and perhaps from the egg chromosomes. There is no doubt that most of the differentiations of the egg cytoplasm have arisen during the ovarium history of the egg, and as a result of the interaction of nucleus and cytoplasm;

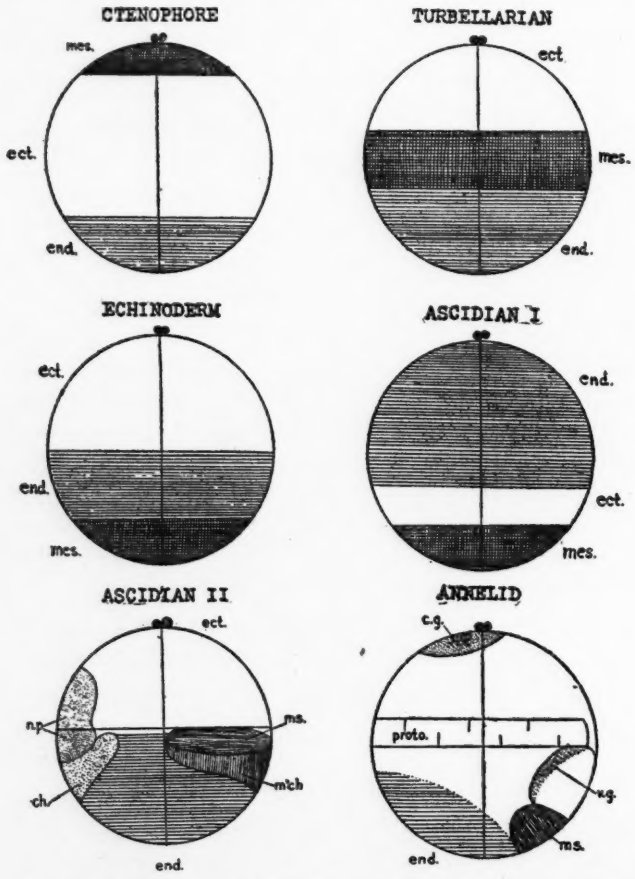


FIG. 45. TYPES OF EGG ORGANIZATION IN DIFFERENT PHYLA; cross-hatched area, mesoderm or mesenchyme (*mes*); horizontal lines, endoderm (*end*); clear area, ectoderm (*ect*). In the first four figures the pattern of localization is that which is found at the close of the first cleavage; in the annelid egg the localization of later stages is projected upon the egg.

but the fact remains that *at the time of fertilization the hereditary potencies of the two germ cells are not equal, all the early stages of development, including the polarity, symmetry, type of cleavage, and the pattern, or relative positions and proportions of future organs, being foreshadowed in the cytoplasm of the egg cell, while only the differentiations of later development are influenced by the sperm. In short, the egg cytoplasm fixes the general type of development and the sperm and egg nuclei supply only the details.*

We are vertebrates because our mothers were vertebrates and pro-

duced eggs of the vertebrate pattern; but the color of our skin and hair and eyes, our sex, stature, and mental peculiarities were determined by the sperm as well as by the egg from which we came. There is evidence that the chromosomes of the egg and sperm are the seat of the differential factors or determiners for Mendelian characters, while the general polarity, symmetry and pattern of the embryo are determined by the cytoplasm of the egg.

It will be observed that the correlation between chromosomes and adult characters is different in kind from that between the cytoplasm of the egg and the adult characters; in the latter case polarity, symmetry and pattern are of the same kind in the egg and in the adult, and the correspondence is comparatively close; in the latter there is no correspondence in kind between the chromosomal peculiarities and the peculiarities of the adult. This fact might suggest that the chromosomal organization may be more fundamental than that of the cytoplasm. There are reasons for believing that many substances of the cell are formed by the interaction of nucleus and cytoplasm, and most probably the chromosomes are an important factor in this process. But in no case is the cytoplasm a negligible factor—in no case does it serve merely as food for the chromosomes. The entire cell, nucleus and cytoplasm, is concerned in heredity and differentiation.

D. The Mechanism of Development

Development consists in the transformation of the oosperm into the adult. What is the mechanism by which this transformation is effected? There is progressive differentiation of the germ into the developed organism, but by what process is this differentiation accomplished?

Many different processes are concerned in embryonic differentiation. From the standpoint of the cell the most important of these are (1) the formation of different kinds of substances in cells, (2) the localization and isolation of these substances, (3) the transformation of these substances into the various structures which are characteristic of the different kinds of tissue cells. We shall here describe only the first and second of these processes which are of more general interest than the last.

1. *The Formation of Different Substances in Cells*

Differentiation consists primarily in the formation of different kinds of protoplasm from the proptoplasm of the germ cells. It is plain that different kinds of protoplasm are present in the two germ cells before they unite in fertilization, but in the course of development the number of these substances and the degree of difference between them greatly increase.

Actual observation shows that by the interaction with one another of

substances or parts originally present and by their reactions to external stimuli new substances and parts appear which had no previous existence, just as new substances result from chemical reactions. This is "creative synthesis" in philosophy, epigenesis in development. Differentiations appear chiefly in the cytoplasm, but only as the result of interaction between cytoplasm and nucleus. Similarly, it may be argued, smaller units of organization, such as chromosomes or chromosomeres, do not in themselves give rise to any adult part, but only as they interact upon one another are new parts formed.

In many cases the first formation of such new substances appears in the immediate vicinity of the nucleus and, like assimilation itself, is evidently brought about by the interaction of nucleus and cytoplasm. In certain cases it can be seen that the achromatin and oxychromatin which escape from the nucleus during division take part in the formation of new substances in the cell body, and since the oxychromatin is derived from the chromosomes of the previous cell division, it is probable that the chromosomes are a factor in this process.

Weismann maintained that the chromosomes and the inheritance units contained in them undergo differentiation by a process of disintegration and that these disintegrated units escape into the cell body and there produce different kinds of cytoplasm in different cells. A somewhat similar view was advanced by deVries in his theory of intracellular pangenesis. However, as we have seen already, there is good evidence that the chromosomes do not undergo progressive differentiation in the course of development; they always divide with exact equality, and even in highly differentiated tissue cells their number and form remain as in embryonic cells.

On the other hand, the cytoplasm undergoes progressive differentiation, and when by pressure or centrifugal force such differentiated cytoplasm is brought into relations with strange nuclei the differentiations of the cytoplasm are not altered thereby, thus showing that the different nuclei are essentially alike and that differentiations are mainly limited to the cytoplasm. Thus the differentiations of cells are not due to the differentiations of their nuclei, but rather the reverse is true,—such differentiations of nuclei as occur are due to differentiations of cytoplasm in which they lie. Nevertheless, differentiations do not take place in the absence of nuclear material, and it seems probable that the interaction of nucleus and cytoplasm are necessary to the formation of the new cytoplasmic substances which appear in the course of development.

2. *Segregation and Isolation of Different Substances in Cells*

But differentiation consists not only in the formation of different kinds of substances in cells, but also in the separation of these substances from one another. This separation is brought about to a great extent

by flowing movements within cells which are associated especially with differential cell division.

In all these processes of heredity and development cell division plays a particularly important part. If cell divisions were always exactly alike there could be no initial difference between the daughter cells, and unless acted upon by different stimuli all cells would remain exactly alike. But there is much evidence that daughter cells are often unlike from the time of their formation, and that different stimuli act upon them to still further increase this initial difference.

(*a*) *Differential and Non-differential Cell Division*

When each half of any dividing unit is like the other half the division is non-differential. So far as we now know the divisions of all the smallest elements of the cell are of this sort; there is no good evidence that the plastosomes, the chromomeres, or the chromosomes ever divide into unlike halves, though in the maturation divisions the separation of whole chromosomes leads to the appearance of a differential division of the chromosomes. But while all of the cell elements may be supposed to grow and divide into equivalent halves, there may be an unequal distribution of these halves in cell division, so that the two daughter cells are unlike. This is what is known as differential cell division and it plays a most important part in differentiation. While the chromosomes are equally distributed to the daughter cells, except in the case of the maturation divisions, the achromatin and the oxychromatin of the nucleus are not always distributed equally and this is probably a most important factor in development. The divisions of the cytoplasm of the egg are frequently differential and such divisions are known to play a great part in the embryonic differentiation.

In the differential divisions of the cytoplasm unlike substances become localized in certain parts of the cell body, chiefly by means of definite flowing movements of the cytoplasm, and when cell division occurs these substances become permanently separated by partition walls. In this way irreversible differentiations are formed. If the formation of partition walls is prevented, the different substances within the cell body may freely commingle, especially during nuclear division when the cytoplasmic movements are especially active; in such cases differentiation is arrested even though nuclear division continues. In the developing eggs of most animals partition walls between daughter cells are necessary to prevent the commingling of different kinds of substances, which are sorted by the movements within the cell and are isolated by the partition walls. In some cases, as for example, in certain protozoa, the commingling of different kinds of protoplasm within a cell may be prevented by the viscosity of portions of the protoplasm, or by the formation of intracellular membranes, or by a reduction to a minimum of the mitotic movements within the cell by the persistence of

the nuclear membrane during division. In general the degree of differentiation may be measured by the degree of unlikeness btween different cells, and by the completeness with which the protoplasm of different cells is prevented from intermingling.

All the phenomena of life, including heredity and development, are cellular phenomena in that they include only the activities of cells or of cell aggregates. The cell is the ultimate independent unit of organic structure and function. The only living bond between one generation and the next is found in the sex cells and all inheritance must take place through these cells. Inherited traits are not transmitted from parents to offspring but the germinal factors or causes are transmitted, and under proper conditions of environment these give rise to developed characters. Every oosperm as well as every developed organism differs more or less from every other one and this remarkable condition is brought about by extremely numerous permutations in the distribution of certain parts of the sex cells in maturation and fertilization. Sex is an inherited character dependent upon an alternative distribution of certain chromosomes of the nucleus. There is much evidence that the factors for all sorts of alternative characters are associated with the chromosomes. The differentiation of the oosperm into the developed organism is accomplished in part by the associations and dissociations of germinal units which lead to the formation of new materials and by the segregation and localization of these materials in definite cells.

Germ cells and probably all other kinds of cells are almost incredibly complex. We know that former students of the cell greatly underestimated this complexity and there is no reason to suppose that we have fully comprehended it. What Darwin said of the entire organism may now be said of every cell.

An organic being is a microsome—a little universe, formed of a host of self-propagating organisms, inconceivably minute and numerous as the stars in heaven.

THE DECREASING POPULATION OF FRANCE

By Professor JAMES W. GARNER

THE UNIVERSITY OF ILLINOIS

I. The Present Status of the Population

ONE of the leading newspapers of France, in an editorial in February, 1912, declared that the day on which the results of the next quinquennial census were known would be one of national mourning for the people of France. The Parisian journals in commenting on the census returns when they were made public in May, 1912, characterized the conditions which they revealed by such terms as "deplorable," "profoundly desolating," "extremely disquieting," "lamentable" and "dolorous." The prevailing tone of their comments was as if the country had experienced some great calamity or had suffered a national bereavement. So profoundly impressed was the government that it proceeded at once to appoint an extra-parliamentary commission (the second since 1902), to "investigate the question of depopulation, and to recommend measures for combatting the evils which threaten the extinction of the nation." M. Klotz, minister of finance, in his address to the commission, urged upon it the necessity of prosecuting its investigations with celerity, for, he said, "depopulation is no longer a vague menace to our country; it is a national danger, at once pressing and immediate, and one which demands rapid and efficient measures." M. Léon Bourgeois, addressing the Congress for Social Hygiene about the same time, spoke in a similar tone, declaring that France was threatened with two dangers, one foreign and one domestic. While she was prepared to make any sacrifice, he said, for the cause of national defense, she must also consider seriously the danger with which the country is confronted by the decline of the birth-rate and the comparatively high rate of mortality among the French people. Speaking before the same congress, Senator Ribot, a former premier, declared that "our people must be instructed in the perils that menace us; it will require all the resources and strength of the government to combat successfully the dangers which now imperil the very existence of the French people." No one can read the comments of the statistical experts, sociologists, economists and publicists on the census returns of 1911 without feeling that the nation is really alarmed at the seriousness of the danger with which it is confronted. The census revealed the fact that in 64 of the 87 departments into which France is divided the population had decreased during the past five years and that the number

of births during the preceding year in the nation at large was inferior by 34,869 to the number of deaths. True, the total population of the republic increased during the quinquennial period (1906–11), but this increase represented almost entirely the growth of Paris and a few other large cities, itself a result of foreign immigration, which now averages over 120,000 persons a year. Only 23 departments (the number was 55 in 1910) showed any increase at all, and except in those departments containing large cities, the increase was trifling. The departments of Upper Loire, Lot and Yonne each lost about 11,000 inhabitants, Allier and Manche, over 11,000, Somme, 12,400, Nièvre, 14,600 and Ardéche over 15,000.

The disquieting feature of the situation is that while the population of France has long been practically stationary and is now beginning to decline, that of her neighbors continues to increase by leaps and bounds. While the French population since 1872 has increased only from 36,102,000 to 39,601,000, or only about three and a half millions, that of Germany has increased from 40,000,000 to 65,000,000, or a gain of 15,000,000 souls, and this in spite of the several millions that Germany has lost by emigration to foreign lands. During this period the population of the United Kingdom has increased from 31,840,000 to more than 45,000,000; Austria-Hungary from 35,700,000 to more than 49,000,000, and Russia from about 80,000,000 to 155,000,000 (1908), and all this notwithstanding the heavy loss which these countries have sustained through emigration to foreign countries and to their colonies.

M. Bertillon, speaking before the Society of Friends of the University of Paris, in 1912, called attention to the fact that in 1815 the French constituted 18 per cent. of the civilized people of the world; now they constitute only 10 per cent. Against 50,000,000 people who speak French, there are to-day, he says, 120,000,000 who speak German and 150,000,000 who speak English. In 1789 France stood first among the powers of Europe in respect to population; to-day she stands sixth and is followed closely by Italy. M. Bertillon pointed out the economic and other consequences to the nation that must result from this loss of population. French exports have almost ceased to increase for lack of producers and manufacturers, while those of Germany have nearly doubled during the last thirty years. In case of war Germany now has fifty per cent. more conscripts than France to put into the field whereas forty years ago the two countries were in this respect on a footing of practical equality. France has no men available to send to her colonies and few to spread French influence abroad. M. Bertillon calls attention to the fact that technical and scientific works whose readers are necessarily limited in numbers but which nevertheless are the essential marks of progress will be published in the language spoken by the largest number of people. For Europe this language was once French, but it has ceased to be such. During the past century, while

the birth-rate of all the other countries of Europe greatly increased, that of France steadily declined. In 1801, the number of births in France was 1,007,000, by 1836 the number had fallen to 927,000, in 1876, it was 847,000; in 1896, 807,000; in 1901, 857,114 and in 1911, 742,114. In 1897 the number of births exceeded the number of deaths by 108,000; in 1902 the excess was 83,000; in 1906 it was only 26,000 and in 1911 there was, as I have said, a deficit of 34,869, an amount equal to the loss of a city the size of Lunéville, Verdun or Bar-le-Duc.

While the natural increase in the population of France has for many years been a negligible quantity, the average annual excess of legitimate births over deaths in Germany is at present in the neighborhood of 750,000 (last year it was 900,000); in Austria-Hungary more than 600,000; in the United Kingdom nearly 500,000 and in Italy more than 300,000. The fact that Germany in particular is adding by natural increase nearly a million souls to her human resources every year, while France is not only adding nothing to hers, but, on the contrary, is losing a portion of what she has, is not only a source of disquietude, but of genuine alarm. In a sense Von Moltke did not exaggerate when he said Germany is gaining every year a battle over France by reason of the addition to her population of nearly a million souls. Nor did M. deFoville, of the Institute, when he declared that France is losing every fifteen years four army corps.

The recent census statistics show a declining birth-rate in all the departments without exception. In many of them the rate of mortality exceeds the birth-rate by a third, while in some it is twice as great. From 1810 to 1911, the birth-rate for France, as a whole, decreased from 31.8 per thousand to 19.6, while in some departments, like Garonne, it is only 13.6; in certain parts of Normandy and Gascony it is as low as 10.9 and even 8. According to statistics published by the city of Paris in April of last year there was an average of but one birth in the capital for every thirty families during the past year.

Parallel with the decreasing birth-rate has gone a steady diminution in the size of French families. In 1800 each household had an average of 4.24 children; in 1860 it had fallen to 3.16, now it is slightly more than two and among many categories of persons like the wealthy of Paris, poorly paid state employés and small landed proprietors in certain provinces it is still smaller, in some cases being as low as 1.5.

According to official statistics published in 1908 by the ministry of labor, there were 1,804,710 families in France that had no children; 2,966,171 that had only one child; 2,661,978 that had two; 1,643,415, that had three, and only 987,392 that had four. Altogether there were only 2,238,780 families having four or more children, leaving 9,076,274 families having from but one to three or none at all.

II. Causes

A variety of causes, hygienic, social, economic and legal, have been offered in explanation of the conditions described above in respect to the state of the French population. First of all, an unnecessarily high rate of mortality among the French people is said to be partly responsible. For all France the number of deaths per 1,000 of population is in the neighborhood of 20, whereas in England, Holland, the Scandinavian countries, Germany and Switzerland it is considerably lower, the rate being as low as 14 in Norway and 17 in Sweden. Infantile mortality is especially high in France, one third of all deaths occurring before the end of the third year. The ravages of tuberculosis among the French also contribute greatly to the elevation of the death rate. M. Bourgeois recently stated before the Congress of Social Hygiene that although the death-rate from tuberculosis had fallen in England and Germany from 11 per 10,000 of the population, the rate in France was 22.5. The rate of mortality on account of this disease is especially high in Paris, where in 1908 there were 13,600 deaths therefrom.

Alcoholism was declared by the Klotz commission to be partly responsible for the high infantile mortality and to some extent also for the small birth-rate. The commission produced statistics to show that in those departments where there has been a large increase in the consumption of alcohol, there has been a corresponding increase in the rate of infantile mortality. Senator Ribot declares that alcoholism and tuberculosis are fast obliterating the French race and this opinion is supported by the testimony of a number of noted specialists in alcoholic diseases. Statistics show that there has been an enormous increase in the amount of alcohol consumed in France (the average per capita consumption is about fourteen litres per year and in certain cities of Normandy it is as high as twenty-nine) and they also show that a large percentage of the inmates of the hospitals and insane asylums are alcoholics. But as M. Bertillon has declared, while alcoholism is undoubtedly exerting a terrible effect upon the quality of the young and is contributing to race degeneracy, it is not an immediate cause of sterility and does not necessarily affect the number of births. Moreover, there are other nations where the evil of alcoholism is equally great, for example, England, Germany and Belgium, and yet those countries have a relatively high birth-rate.

The decline of religious faith and of traditional beliefs among the French is regarded by many persons, among whom may be mentioned the distinguished economist, Paul Leroy-Beaulieu, as one of the contributory causes for the small birth-rate. The scriptural injunction to multiply and replenish the earth no longer has the moral influence upon the French mind which it once had. The obligation to rear families which has always been regarded as a religious duty naturally rests

lightly upon a people who have all but repudiated religion. The adversaries of religion, however, place the responsibility for the low birth rate at the door of catholicism which has not only withdrawn from married life a large portion of the population both male and female, but does not encourage marriage among the laity. The latter charge the catholics emphatically deny, and as evidence that catholicism is not responsible they point to Brittany, Finistère and other strongly catholic provinces where the birth-rate is the highest in France. If the birth-rate for all France, says M. Leroy-Beaulieu had been since 1871 equal to that of Finistère, France would have to-day 53,000,000 inhabitants instead of only 39,000,000. Moreover, the catholics point out that in Quebec, a strongly French catholic province, the birth-rate is more than twice as high as that of France, and that Belgium with its comparatively high birth-rate is a country where catholicism is strongly intrenched. It is sometimes complained that one cause of the evil is to be found in the paucity of marriages, but the statistics show that there has been a steady increase in the number for many years (*e. g.*, from 269,332 in 1890 to 307,788 in 1911, and this notwithstanding the fact that there was little increase of population during this period), yet the birth-rate has declined. It seems clear that it is not more marriages that France needs, but more productive marriages; it is infecundity that is responsible for the diminishing population and not lack of marital unions.

Some students of the question, like M. Henri Joly, see in the granting of divorces, the number of which steadily increases every year, one of the secondary causes; but this may be doubted. On the contrary, it might be argued that divorce conduces to the increase of the birth-rate by permitting the dissolution of sterile unions and the contracting of others. Moreover, there was no divorce law in France before 1884, yet the population had long since ceased to increase except in trifling proportions. Finally, divorce is practised in other countries where the birth-rate is high; if it contributes to the diminution of the population in France, why does it not have the same effect elsewhere? The prohibition of the judicial determination of paternity in the case of illegimate children has long been regarded as a secondary cause of the low birth-rate, since it encourages illicit cohabitation in the place of lawful marriages. This legal incentive to "free unions" has been removed, however, during the past year by the enactment of a law empowering the courts to ascertain and determine the father of an illegitimate child which he refuses to recognize. The enactment of this law, says the *Temps,* was a great victory in the interests of morals and humanity and one which required fifty years to achieve.

The spirit of luxury and ease and the high state of wealth are also held responsible for the disinclination among the French to rear children. The census statistics show that in the richest regions of France,

like Normandy, Burgundy and the Valley of the Garonne, the birth-rate is the lowest, while in the poorest provinces like Brittainy, the Nord and Lozère it is the highest. They show also that it is twice as high among the poor of Paris as among the rich and that it is fifty per cent. higher among fishermen and sailors than among landlords and the professional classes. But this is a phenomenon not peculiar to France; it is found in all countries where there is a high state of civilization and therefore does not explain why the birth-rate is lower in France than in other countries where similar conditions prevail.

Our conclusion, therefore, is that the principal causes of the low birth-rate are not due to external conditions, social, legal or religious, but are the result of the general attitude of the French toward family life. The relatively high rate of mortality, inadequate hygienic conditions, alcoholism, divorce and the other causes mentioned may be contributory factors, but the chief reason is that the French people do not desire to have children. This attitude has been powerfully accentuated by the neo-Malthusian propagandists who by personal solicitation and the distribution of literature encourage the voluntary limitation of births and the practise of abortion, under the pretext of hygiene and the dissemination of philosophic and scientific doctrines. Limitation of the population is to them a legitimate means of combatting poverty and misery, a policy all the more justifiable, they argue, because of the high cost of living and the increasingly hard struggle for existence. Quality rather than quantity of population, they maintain, is the true test of civilization and national greatness. Moreover, the population of France is already as large as its resources can adequately support and therefore nothing is to be gained by producing a surplus to be forced by necessity to emigrate to America or to Madagascar and to the colonies of Africa. This very active propaganda is now being vigorously combatted as a national crime by men like Jules Lemaître, Edmond Perrier, Senator Berenger and others, and a bill for its suppression is being considered by the senate with every likelihood of becoming a law at an early date. Statistics seem to leave no doubt that the propaganda in favor of race suicide is exerting a marked influence on the birth-rate in many parts of France. In Roubaix, for example, where it has been particularly active, the number of births decreased from 3,837 in 1897 to 2,568 in 1906. Likewise in Turcoing the birth-rate has fallen from 34 per 1,000 inhabitants to 19 since the beginning of the propaganda in that city. This propaganda, says Dr. Lebec, is costing France an army corps every five years. Senator Paul Strauss in reporting the conclusions of the extra-parliamentary commission on depopulation recently referred to the "agonizing results" of the Malthusian crusade, and declared that statistics collected by Dr. Doleris showed that between 1898 and 1904 the number of cases of abortions treated in the maternity hospitals had tripled and that the number

represented 18 per cent. of all cases treated in such institutions. In Paris the number of abortions is estimated to exceed the number of births and fully two thirds of these are said to be provoked. Dr. Georges Bertillon estimates that the annual number of such cases is not less than 50,000 for all France, and Premier Barthou in the course of the discussion during the past summer of a proposed law to restrain the practises of the Malthusians asserted that the number of abortions was probably as high as 100,000 per year.

One undoubted reason for the voluntary limitation of the number of births is to be found in the small incomes of the laboring classes and the petty employés of the state. That a laborer who receives but 80 cents a day or a letter carrier whose salary is only 200 or 250 dollars a year can not rear a family, especially in a city like Paris, however much he may desire to do so, is a proposition which is scarcely controvertible. Consequently they feel under an economic necessity of limiting the size of their families. It is notorious that the number of functionaries in France is excessive (nearly one million, or one fortieth of the total population) and that they are miserably paid, their average salary being scarcely more than 500 dollars per year. This explains why the birth-rate among them is lower than that of any other class except the rich, the average number of children per family being but one and a half.

Students of the depopulation problem are all agreed that another important cause of the voluntary limitation of births is the excessive spirit of economy and the passion for saving which prevails among all classes in France and especially among peasants, shopkeepers and small proprietors. Statistics show that in those communities where the number of certificates of deposit in the savings banks is the largest, the birth-rate is the lowest. Every father feels under the necessity of providing a dot for his daughter and it is one of his chief ambitions to leave an inheritance for his sons. Among the poorer classes this ambition can be realized only when the number of children is limited. There is also among the French an extreme reluctance to see their fortune divided through the operation of inheritance laws. As the existing law does not permit free testamentary disposition, but allows each child an equal share of the inheritance, the only way by which the father can prevent the division of his estate after his death is to leave but a single child to inherit it. The French peasant loves his land more than he loves children, and his ideal is, therefore, a single heir married to a single heiress. He is willing to have his name disappear with his death if his heir is a girl, rather than see his estate divided, which must necessarily be the case if he leaves several children. Therefore he leaves only one. M. Paul Leroy-Beaulieu, who since the death of M. Levasseur is probably the highest authority in France on matters relating to population, attributes the low birth-rate to the new democratic conception of the family—a view which regards children as a

burden and which desires that the family from one generation to another shall rise in the social scale. Every parent desires that his children shall occupy a higher social position than he himself did. The laborer's ambition is to see his son a landlord or a functionary; the peasant wants his son to be a *monsieur*, an advocate, a doctor or a merchant; and the *petit bourgeois* has similar ambitions. The only means of realizing such ambitions is to limit the number of children to whom the fortune is to be left. This *capillarité sociale*—this striving of each social molecule to rise higher in the organism—is, he thinks, the principal cause of the infecundity of the French race, at least during recent years.

III. Proposed Remedies

Such are the more important causes to which are attributed the declining population of France. Turning now to a consideration of the proposed remedies, we find that they are as various as the causes and are hygienic, legislative, administrative, fiscal and social in character. First of all, the death-rate, especially among infants, may, and should be, reduced to the level attained in other countries of Europe. More than one sixth of the children born in France, or between 150,000 and 170,000, die every year, and of these one third die during the first month after birth. This is a "veritable disaster" to the nation, says the commission on depopulation, and it should be met by better sanitary measures, medical surveillance, more effective inspection of the milk supply and gratuitous assistance to the poor. Maternal nourishment should be encouraged by every means, in default of which measures should be taken to assure a supply of sterilized milk to children who are dependent upon the dairy for their nourishment. Furthermore, legislation should be enacted forbidding the employment of mothers in industrial establishments at least six weeks before and after *accouchement*, and such establishments should be required to provide places at which babies may be nourished by their mothers.[1] By such measures as these at least 50,000 children, it is claimed, could be saved for the nation every year.

State aid and initiative in the construction of cheap tenement houses for large families, in the cities where rents are high and the cost of living excessive, has been advocated by many social reformers. Last year the parliament adopted a building code governing the erection of such houses, and it contained special provisions in favor of large families. During the past year a law was also passed providing for public assistance for large families and making the expense of such assistance obligatory upon the departments, but providing also that the state and the communes should share a portion of the cost. The law enacts that every head of a family having more than three legitimate children and

[1] Such a law has been enacted since the above was written.

the resources of which are insufficient for their support shall receive an additional grant for every child above the third under thirteen years of age. The amount of the allocation is to be determined by the municipal council subject to the approval of the Council General and the Minister of the Interior, but it can not be lower than 60 francs per year for each child nor superior to 90 francs.

More effective measures for combatting tuberculosis, the abolition of divorce, legislation permitting the judicial determination of paternity in the case of illegitimate births and the suppression of convents with their 60,000 female celibates are some of the other secondary remedies proposed, but it is certain that such measures will not reach the real cause of the evil. As I have said, the parliament passed a law during the past summer authorizing the judicial determination of illegitimate paternity and its results will be watched with interest. In regard to the suppression of convents, M. Bertillon has remarked that at best it would not result in the addition of more than four or five thousand children annually to the population, whereas France needs at least 500,000 more births per year.

The restoration of religious sentiments would, according to many students of the problem, result in a new attitude toward the obligation to rear families. Among those who share in this view is M. Leroy-Beaulieu who, in a recent article in the *Journal des Débats,* protested against the government's hostile attitude toward the traditional religious beliefs of the people. It is necessary, he declared, that our statesmen should at once abandon the absurd and odious war which they have waged for a quarter of a century, and particularly during the last fifteen years, against our country's traditional religious beliefs.

The criminal suppression of the methods now being employed by the Malthusian propagandists is another proposed remedy. During the past year the senate has had under consideration a law for this purpose and one which proposes to give the correctional tribunals jurisdiction of cases of abortion, with a view to rendering convictions in such cases more certain. Senator Barthou, Premier and Minister of Justice, in advocating the adoption of this law in 1912 said: "I am certain that the senate will understand that the proposed law is a measure of public safety and national salubrity." There is little doubt that the suppression of provoked abortions and of infanticide would have important results upon the increase of the population, and it is equally certain that the best public sentiment of France demands legislation for this purpose, but its enforcement would obviously be attended with great practical difficulties.

Simplification of the formalities of marriage with a view to encouraging an increase in the number has also been advocated. It may be added that by laws passed in 1896 and 1897 a number of the old rigorous requirements of the civil code were abolished, notably those

relating to age, residence in the commune and consent of parents, and the removal of these restrictions was actually followed by a large increase in the number of marriages (from an average of 281,000 per year prior to 1896 to 323,000 since 1907), but there is much complaint that the formalities still required and the legal fees exacted are excessive and constitute a real hindrance to marriage. But, as I have remarked, the number of marriages is already comparatively large in France and there has been a wholesome increase from year to year. In all probability, therefore, such a remedy would not produce any appreciable results.

The modification of the naturalization laws with a view to facilitating the acquisition of French nationality and thereby encouraging immigration has also been advocated as a means of increasing the population. The existing requirements are too rigid, says M. Leroy-Beaulieu; France, he thinks, could well afford to naturalize 50,000 foreigners a year since the density of her population is far less than that of Germany, Italy and Belgium, and by thus encouraging immigration the country would find a new source from which its declining population could be recruited. Reform of the inheritance laws so as to allow the father a right of free testamentary disposition, as is the rule in other countries of Europe, has been widely urged in recent years. The existing provisions of the civil code, as I have said, compel the division of the inheritance when there is more than one child, and the general reluctance among small proprietors of having their estates split up into parcels conduces to the voluntary limitation of their offspring. All those who have investigated the question are of the opinion that the proposed change would result in a marked increase of the birth rate. M. Bertillon goes further and proposes a more heroic remedy, namely, the treating of single children in respect to an inheritance as if they had brothers and sisters; he would, for example, impose a tax of 30 per cent. on the inheritance when there are two children and 60 per cent. when there is but one. In other words, where there is but a single child he would have the state confiscate that portion of the inheritance which would go to the other children if there were any.

A more reasonable proposal of this kind has been made by Colonel Toutee, namely, that the law should regulate the inheritance according to the size of the families of the heirs. Thus if two heirs are left, one of whom has three children and the other none, the estate should be divided into five parts, of which four should go to the first heir and one to the second.

The suggestion has often been made that the state should offer bounties for the production of children and numerous bills have been introduced into the parliament for this purpose. One of the more recent was a proposal by M. Messimy, a former minister of war, providing for the payment of a bounty of $100 for every child above the

fourth. But for fiscal reasons such proposals have not been favorably received. A proposed measure which has many advocates is the employment of the taxing power for the purpose of chastising celibates and the heads of families without children. The rearing of children, says M. Bertillon, one of the strongest advocates of the taxation of celibacy and infecundity, should be considered as a public duty in the same way as service in the army and the payment of taxes. The act of rearing a child should be considered as equivalent to the payment of a tax; he who does not discharge this duty should be subject to a sur tax; those who do, should be wholly or partially exempted from taxation. The statistics show that there are more than 1,500,000 male celibates over 25 years of age in France, nearly 2,000,000 families without any children at all, nearly 3,000,000 which have but one child each, and 2,500,000 which have but two each.

A sur tax on such persons would be to a large extent a tax on the rich and well-to-do and it would make possible a reduction of the taxes on the comparatively small number of large families which are to be found, for the most part, among the poorer classes.

Fiscal measures whose purpose is to discriminate and to punish celibacy and infecundity are, however, objectionable to many persons who believe that the better remedy consists in measures of a more elevated character addressed to the moral sentiments—measures which will tend to reward and honor fecundity and which shall have the character of a mark of recognition by the state of its esteem for those who have contributed to its strength and perpetuity by the rearing of families. Such a measure is the oft-repeated proposal to give the preference in the matter of appointments to the lower posts in the public service which do not require special qualifications, to the heads of families and especially to the heads of families containing more than three children. This proposal has been advocated by Messrs. Bertillon, Leroy-Beaulieu, Levasseur, Senators Lannelongue, Piot and many others and has been the subject of numerous bills in parliament. M. Leroy-Beaulieu has, I believe, even proposed that no one be appointed a functionary who does not have at least three living children. This proposal recalls the action of a former prefect of the Seine, M. Poubelle, who refused to appoint to certain inferior positions, any man who was not the father of at least three children. But this is a rather heroic remedy, hardly conducive to administrative efficiency, and would scarcely be practicable unless the state should increase the present miserably low scale of salaries now allowed its employés, many of whom find it impossible to support a family of three children out of their official incomes.

A more moderate proposal is that the state should take account of the size of the family in fixing the salaries and retiring pensions of

public functionaries. This suggestion has been made by the commission on depopulation and by many writers and social reformers. Bills embodying this idea have frequently been before parliament, and in 1908 the Chamber of Deputies adopted a resolution inviting the government to introduce a *projêt* for granting to the employés of the state receiving small salaries an allocation in proportion to the size of their families. Some of the administrative departments have in fact already adopted such a policy. Thus in the department of indirect taxes, every employé whose salary is less than $440 a year and who has three or more children under eighteen years of age receives a subsidy of $12 a year. Likewise in the post-office department and in the customs service there is a similar grant of $9.00 per year. Somewhat similar allowances are made by the state railroads and other branches of the public service. Thus the principle has already been given an extended application, though on a somewhat small scale. Not very different in principle and without the objections which characterize punitive taxation of celibacy and infecundity is the proposal advocated by M. Leroy-Beaulieu and others to take into account the size of the family in fixing the amount of the personal tax, which, in France, is mainly a tax on habitation and one which therefore weighs heavily upon renters having large families. This principle has been embodied in the tax systems of various continental states, notably in the German income tax law which allows a reduction of $12.50 in the amount of the tax for every child under fourteen years of age. The abolition of the tax on doors and windows, letters patent, the *octroi* and others of a similar character which are peculiarly burdensome to the poor would be, as has often been asserted, conducive to the rearing of larger families.

IV. Conclusions

Such are some of the means that have been proposed for combatting the conditions which threaten France with depopulation. Some of them, like discriminating measures against celibates, the payment of bounties for the production of children, the exemption of heads of families from certain public impositions, and the partial confiscation of inheritances where there is but a single child, were tried by the Romans, but they were largely illusory and of little effect. Of the other measures proposed, some are impracticable, others are impossible of execution and still others would be productive of but slight results. The true remedy lies not in legislative, administrative or fiscal measures, though some of these may contribute toward the checking of the evil, but in a reform of the morals and customs of the French people. There must be a fundamental change in the attitude of French men and women toward the obligation to rear families; there must be an awakening to the duty which devolves upon the citizen to contribute to the

perpetuity of his race through the rearing of children as to defend it in time of war or to pay taxes for the maintenance of government. Any and all measures which shall contribute toward an awakening of the people to the importance of this national duty are worthy of encouragement and of adoption. The solution of the problem is not dependent upon external measures and remedies; it is to be found almost entirely in the moral sentiments and social customs of the people themselves. Zola did not exaggerate when he said: "France will never be depopulated unless she wishes to be." The late Emile Levasseur once remarked that it was "truly humiliating to think of a nation of thirty-eight million souls, which by its age, its industry and commerce is one of the wealthiest of the globe and which by its intellectual activity, its arts and its sciences is one of the most capable of enlightening the world and which under republican government has during the last quarter of a century recovered in the European concert the place of a great power, is a nation which, according to the statistics is destined to disappear." Mr. Roosevelt's warning at the Sorbonne in 1907 that "neither luxury, nor material progress, nor the accumulation of wealth, nor the seductions of literature and of art, should take the place of those fundamental virtues the greatest of which is that which assures the future of the race" made a deep impression at the time it was delivered and has not been entirely without result. It is no exaggeration to say that at no time in the past have so many thoughtful Frenchmen been aroused to a realization of the consequences that must inevitably result from the continued decline of the population. This is fully attested by the organization of societies to increase the population, by the formation of parliamentary groups with the same end in view, by the appointment of parliamentary and extra-parliamentary commissions to study the question and to search for the remedies, by legislative and administrative measures of various kinds and by the discussions and publications of scientific bodies and of economists, sociologists and publicists. No one can read the extensive literature to which the discussion of the problem has given rise without feeling that the question is now regarded as a serious and pressing one and that the nation proposes to grapple with it as such.

THE RISE OF A NEW PROFESSION

By Professor EDWARD D. JONES
UNIVERSITY OF MICHIGAN

IF we consider the industrial history of the United States, for the span of a long generation, dating backward from this year of grace to about 1840, we can distinguish at least three great movements which have occupied the minds of men in industry.

The Age of the Pioneer

The first period was still engaged, as previous decades had been, in the process of settling the country, and of starting those simple basic industries which are the foundation of civilized life.

In 1840 Boston was not yet connected with Albany by rail, nor Albany with Buffalo. The grain elevator had not yet been devised; and no coke ovens yet existed near Connellsville. The first steamboat had just been seen at the Soo; and in Iowa they were plowing a furrow from the Mississippi river west 100 miles to guide settlers. A few pioneers were beginning to pass over the Oregon trail; and Fremont was just describing Utah in the papers. It was not until 1845 that copper was produced in upper Michigan. It was only in 1852 that Chicago was connected with the East by railway. The locomotive did not reach the Missouri river until 1859, nor the Pacific coast until ten years later.

The mention of the pioneers calls for a word of tribute. Our nation's first industrial task was the stupendous one of clearing the farms, and of building the common roads, and of establishing villages and cities, and opening outlets for the marketing of surplus products. Perhaps the history of the pioneers was, indeed, but "The short and simple annals of the poor." Carlyle dismissed America with the contemptuous summary, "Hitherto She but plows and hammers." The work of opening the country was simply the first duty. But it was not industry of the cramped mechanical sort which Carlyle knew in the grimy manufacturing towns of Scotland. The pioneers partook somewhat of the nature of the explorers. Their advance westward had the stirring quality of a military reconnaissance directed against the hostile forces of nature which were entrenched in the wilderness. The victory was not to mere economy and patience, and the weaker virtues, but to industry animated with boldness, directed by invention, and ennobled by sacrifice for the future. The pioneers were rugged, self-reliant men

and busy contented women. Into the enjoyment of the fruits of their labors we have all of us entered.

The Age of Mechanism

The second industrial movement of the period we are considering centered upon the task of providing an adequate mechanical equipment. Its purpose was to develop inanimate sources of power, by means of which the burden of physical toil could be, to some extent, lifted from human shoulders.

Accordingly, the second act transfers the scene of industry from the field to the factory. The first billet of Bessemer steel was produced in America in a little furnace at Wyandotte, near Detroit, in 1864. The first band-saw was brought from Paris to New York in 1869. The first middlings purifier was built in Minneapolis in 1870. The twine-binder was invented in 1874. In the wonderful Centennial year of 1876, there was given to the country the telephone, the incandescent light, the typewriter and the first steel-frame building. Since those years, the American farmer has come into the possession of a well-nigh perfect equipment of agricultural implements. Our factories have been filled with machinery, our offices with appliances, and our stores with furnishings, until it is generally conceded that no people of the world excel the Americans in the use of mechanical facilities.

The Age of Administration

And now that these achievements are no longer in their origins, and the issues called up by them are recognized as virtually settled, and there is no longer any opposition to try men's souls in establishing and defending them, a third great industrial problem can be seen to emerge and become the center of interest. This is the question of administration. Upon this generation is laid the task of discovering, testing and establishing in general use those methods of organization and management by which the great productive agencies now within the possession of industry can be united, subjected to proper control, stimulated, guided, inspected, instructed and rewarded, to the end that they may serve society with efficiency. In short, the problem is that of originating and formulating a science of administration which shall comprise those basic principles and practical policies required for the guidance of great affairs.

Self-Made Men

This administrative phase of our industrial evolution has, of course, already a history of value, and this history is concerned with the doings of a very interesting generation of men. For years the United States, with its enormous domestic market, its ample capital, its freedom from tradition and its colossal daring, has been perhaps the most favorable

spot in the world for trying out new ideas of organization and management.

The men who first took advantage of these conditions were, for the most part, self-made men. We often refer to them as captains of industry. The majority of them were individuals of motor temperament, endowed with exceptional talents, who fought their way upward and gained eminence, through a rough-and-ready struggle for the survival of the fittest.

These men seized leadership by right of ability, but, technically speaking, they secured it as the perquisite or privilege arising from the ownership of great fortunes. They lived in a day when men generally managed their own capital. In most cases they were the first to build up institutions of great size in the lines of industry with which they were connected. These circumstances involve the point that had not these men built up fortunes they could not, individually, have become administrators. The price of their economic power was to make everything bend to the getting of money. In other words, they had to create the kingdoms over which they later ruled.

Their policies were, therefore, like those of most conquerors, simple, often crude and sometimes morally abominable. They were often drive-masters, and not infrequently they resorted to the intellectually contemptible methods of unfair trade. Yet we do not withhold admiration for the splendid independence and energy which they exhibited. They generally possessed a thorough knowledge of details, due to the small beginnings from which they had started. They had the ease and speed of decision due to long experience and gradually imposed responsibility. The names of the leaders of this generation of giants will long remain household words in America.

If we pause to consider broadly this introductory period of administration, we can see that it was marked by strenuous rather than finely calculated action, and by physical rather than intellectual tests. Most important of all, it was characterized by a confusion or conflict between the principles of the true art of administration and the requirements of the process of amassing a fortune. We are so accustomed to measure mastership in industry by the increase of the wealth of the individual, that it is difficult to perceive that there can be any such thing as an independent art, with principles and ideals of its own. If we turn to politics we are able to see that a man's record for efficiency as a mayor of a city does not depend upon his getting rich in office. Neither do we measure the skill of our military leaders by their strategy in gathering private booty, nor the capacity of our statesmen by their ability to insure tranquillity and prosperity to themselves, rather than their country. In all of these cases we have the conception of the requirements of an art or polity. The standards of judgment are entirely distinct from the state of the private fortune of the administrator. It is this

method of judging which is beginning to make itself felt in industry. That we have not more generally used such tests hitherto is one of the reasons why broad and intellectually respectable principles have been so slow in gaining control of industrial action, and why it has been so difficult to detect the really capable administrators among the crowd of men who are merely, and perhaps even accidentally, rich.

The early administrators, living in a highly individualistic and self-confident society, worked out rules of action each man for himself. Many of them were rather builders than administrators, emphasizing the builder's tests of size and growth. They made many mistakes which they could not perceive because, living in a community which had broken sharply with the past, and which had little applicable history of its own, they thought little of lessons drawn from the past. As they were devoted to little else than business, they saw few analogies between the administration of industry and of other forms of social action.

Being so much in a world of their own creation, they looked upon the administration of the organizations with which they were connected as their own private business. Such organizations were, therefore, in many cases, no more than mere extensions of themselves, incapable of serving as the object of the loyalty of the various classes of persons which might become connected with them. While these men sometimes made notable technical achievements, and claimed the title of super-men, they were, many of them, mere master mechanics, putting men and equipment together into corporations in a wooden way and driving them with their individual will power, rather than true administrators with a social sense.

And so it is that, in spite of the magnificent physical development of industry, and the more noble spirit which now begins to animate it, the conduct of affairs is often thought of as something cold, mechanical, and out of line with the ethical feeling of the time—as a matter of endless negotiations and compromises and makeshifts which can not bottom themselves on permanent principles. And, because it has received this reputation, many fine spirits keep clear of it, as they do also from politics. And many others who take part in it do so without making a fair effort to comprehend its possibilities.

New Conditions

Since the ranks of the first generation of administrators have begun to be seriously thinned by death, a notable change has been taking place in the character of our industrial leadership and in the conditions under which it is exercised. The natural growth of businesses into units embracing, under a single administration, hundreds and even thousands of stockholders and employees, and which must unite many minds in operations requiring long periods of time for their completion, calls for

searching tests and clear and stable policies. The use of the corporate form of organization, which makes the business unit the dependent creature of the state, coupled with the increasing sensitiveness of public opinion to the probity of the financing and the humanity of the operative policies employed, unite to demand a more skillful diplomacy, and methods which will bear public inspection. The question of getting adequate administration has now become pressing.

Administrative Helps

If the task of the executive is now more difficult than before, there have been provided various helps to assist in its performance. In the first place, the physical sciences have been applied to industrial operations in a multitude of ways in recent years. They assist in the testing of materials, the refining of productive processes, the preservation of the health of the operative, the sharpening of technical standards, and the provision of new forces and instrumentalities. A second aid is the greatly improved systems of accounting and cost accounting, and the developing theories of valuation, which serve as the administrator's chief instruments of precision, where problems of value rather than problems of physical processes or of human nature are concerned. A third aid is what is commonly called "system"; a somewhat indefinite mass of rules of procedure, together with appropriate equipments, relating especially to office work, and representing the accumulated experience of innumerable official minds. The most recent aid is "scientific management" which, taking its rise as a philosophy of the shop, has culminated in a group of principles constituting an encouraging earnest of a forthcoming more fully developed science of administration.

The Professional Administrator

The large business enterprises now required to meet society's need are gathering the money of hundreds of investors, so that individual or family domination resting upon ownership must decline as a system. Between the multitude of stock and bond holders, on the one side, constituting the proprietors, and the still greater multitude of employees, on the other, there is being created a central strategic position to be occupied by the professional administrator. The whole situation of industry now conspires to create an opportunity for a new race of executives which shall justly appreciate the various classes of responsibilities resting upon it. Upon these men will rest a sort of trusteeship to preserve the property entrusted to them, and a sort of leadership to guide and guard their employees. Upon them will also rest a general responsibility to the public to help this day to live its life, and this generation to make its contribution to progress.

Wanted, therefore, new leaders for industry, who shall unite with

native talent, trained minds. Who shall believe that the sea of affairs can be charted, and can be sailed by the aid of eternal principles and a fine exact technique of diplomatic and humane methods, and who shall be at least as much devoted to the ennoblement of their art as to their own advancement.

Transitional Difficulties

The new order always evolves out of the old with pain and misunderstanding. The new is long looked upon from the inadequate viewpoint of the old. The exigencies of the new situation are always upon us before the teachings of the old have been sufficiently deliberated upon to yield a settled philosophy of action. It is not surprising that this generation should be embarrassed in finding new maxims and ideals, while it is yet blinded by the brilliant achievements of the age of the captains of industry. The shadows of the great founders still fall upon the present-day executive in many forms. In one case it is the tradition of methods once successful, and of conceptions and tests once considered adequate. In another case it is embodied as the incompetent heir, invested with an estate and the glamor of a successful name, and set as an amateur to rule over experts. Again, the shadow of a departing order takes the form of a vast enterprise, which was, perhaps, originally builded with enthusiasm to great size and power, but which is now a shell with many a sheltered spot within, where weak men may vegetate as clerks, perpetually referring matters from one to another, or strong men may be induced to trust to "the impulse of an early start," or to "interlocking directorates," or "banking control," or "dominating influence on the market," or to "predatory competition," or to anything else than service.

Perhaps the chief hinderance to the development of the scientific administrator in America will prove to be what we may call the danger of the entrenched position. The significance of this danger was long ago pointed out by Machiavelli, who warned his ideal prince of the harm wrought by strong fortresses. His words, written in 1513, are still full of significance. He said,

> Whenever either princes or republics are afraid lest their subjects should revolt, it results mainly from the hatred of the subjects on account of the bad treatment experienced from those who govern them; and this comes either from the belief that they can best be controlled by force, or from lack of sound judgment in governing them. And one of the things that induce the belief that they can be controlled by force is the possession of fortresses with which to menace them; and thus the ill treatment that engenders hatred in the subjects arises in great measure from the fact that the prince or republic hold the fortresses, which (if this be true) are therefore by far more injurious than useful. For, in the first instance, they cause you to be more violent and audacious towards your subjects; and next, they do not afford the security which you imagine.

And, further, he says:

A good and wise prince, desirous of maintaining that character, and to avoid giving the opportunity to his sons to become oppressive, will never build fortresses, so that they may place their reliance upon the good will of their subjects, and not upon the strength of citadels.[1]

Whence the Supply Will Come

In this day of large and permanent undertakings, industry can not afford the risk of administrators who, being ignorant of principles, must govern by extempore decrees. Nor can it endure to educate those who will become wise only through disasters. Society is no longer satisfied to prepare its physicians or lawyers or engineers by an unregulated process of learning through experience. If administration is an intellectual pursuit, it is not sufficient to trust to such processes for administrators.

Furthermore, business experiences now less than formerly offer themselves as an educational ladder apt for the upward climbing of the growing mind. It is only in the world of small independent business that responsibility increases gradually and *pari passu* with ability. The typical captain of industry advanced step by step. As his experience and powers of mind grew, his business increased and enlarged his responsibilities by almost imperceptible increments. In the end he emerged, as a scholar might graduate from a carefully graded school, having passed through a finely graduated scale of functions, extending from the simplest to the most difficult things. Business experience less and less offers this encouraging educational aspect. Superior minds are as much wanted as ever, but they are wanted already trained in those general principles of administration which the last generation only grasped as the result of prolonged experience. Young men must now expect to enter some department of an organization which is already large, and to remain for long periods engaged in highly specialized functions, making such upward advance as is made by sudden leaps.

Already the dearth of administrators, who are grounded in general principles, is keenly felt in industrial affairs. The late Mr. Dill once said that he could secure a million dollars ten times while he was finding a man with the capacity to administer the affairs representing a million dollars at work. One of the reasons for the excessive concentration of administrative control in American business is the lack of an adequate supply of executives. And this is also one of the reasons why we overload good men and wear them out so rapidly.

What natural processes fail to do for us we must accomplish by educational agencies. To make education effective, however, we must establish the principles and policies which are to be mastered, so that training may form the mind of the executive more certainly, more rapidly, and more thoroughly than unregulated experience can do.

[1] "Discourses," Bk. II., Ch. XXIV.

New Conceptions

Great leaders come in response to great issues. When the school can present to its students a stimulating view of life, a superior raw material is attracted to it as by a lodestone. In the struggles of life men are inspired to great exertions when new ideals become vivid to them. War produces capable generals, intellectual conflict breeds a generation of acute thinkers, prophets arise to preach new gospels. It matters little what difficulties there are. "Truth," says Nietzsche, "does not find fewest champions when it is dangerous to speak it, but when it is dull." Industry insists upon efficiency, but efficiency may be chiefly insured by discovering great inspiring tasks.

The old ambition to build up big business units, and to accumulate great fortunes, is now no longer quite as fresh and full of zest as it once was. It does not get the response, and call out the best men, as in the old dramatic buccaneering days. To simply repeat what the last generation did in the way of piling up fortunes, and to do it on the same intellectual and ethical and esthetic plane, but without the novelty of being the first to do it, nor the freedom of action of the day of *laissez faire,* is not to set forth a very exciting aim. In the sphere of the intellect there is nothing especially notable about doing it. The hungry intelligence of industry is asking for great new objectives worthy of effort, like the opening of the continent or the building of the railroads. A new and larger conception of the function of industrial leadership is called for. The great resources of the country subdued by the pioneers, and the elaborate equipment provided by the engineers, combine to set the stage for a high statesmanship and for a fine diplomacy to begin to play their rôle in industry. Since it inherits ample physical equipment, the new generation can be less material in its aim, and give itself to providing an intellectual equipment. As we live in a more advanced stage of society, the thought of the administrator should be less of equipment than of policies governing operations, less of operations than of ultimate ends, less of his own part in those ends than of the harmony of the ends themselves with the aspirations and constructive tendencies of society. The result of this can be nothing less, ultimately, than a body of broad, permanent, and socially beneficent principles of action, to which superior minds, forming an aristocracy in industrial affairs, will swear allegiance.

The administrator who is willing to take part in this movement will find himself upon an intellectual frontier, with the opportunity opened before him, as before his forefathers, to become a pioneer. It is not now a frontier of axe and plow, nor of engines and machinery, but of principles and policies. The administrative problems awaiting solution are almost innumerable. The executive who carries the scientific spirit into his work will find an opportunity to make more clear the concep-

tion of authority and responsibility, and to formulate the rules of their distribution. He will study the coordination of mutually functioning agencies, and the means of their supervision. He will find need to more precisely determine the basis upon which rests the division of labor between administration and operation, and between principal matters and details. He will concern himself with the meaning and use of standards and sequences and schedules, and will attack the great problem of framing a theory of rewards and punishments adequately adjusted to the moral sense of the time.

The Fellowship of Administrators

What the military leader was in the ancient days of constant war, and the statesman in the period of the formation of great empires, the industrial executive may be considered to be in this commercial age. He is the leading exponent of organized action in the world. He should dignify his task, boldly conceiving it on the highest plane of which he is capable. He is the intellectual heir of all the executives of the past, and has resting upon him the mandate not to disgrace the succession. It is open to him to maintain a stimulating communion with his predecessors—with all the great military leaders and statesmen and diplomats whose history is preserved for us—and from their experience to gather basic principles of action. Why should not the business executive practise Cæsar's leniency, and his art of making common cause with his men, or endeavor whether Napoleon's celerity may not be used in the bloodless battles of economic service? Why should he not be stimulated by Richelieu's example to strive for coolness in analysis, or be moved by Sir Philip Sidney's charm to practise the art of winning friends?

Brought into contact with the thoughts and deeds of great minds, the business executive need not feel alone in the smallest village or the most distant engineering camp. He will find that before him the great company of the world's executives has had to deal with the same weaknesses of human nature as those against which he combats, and has relied upon such virtues and employed such methods of organization and administration, in bringing men to effective joint action, as are open equally to him. The fields of leadership may, indeed, have been different, but the fundamental principles have been largely the same.

Viewed thus, work again becomes a challenge. The function of the business executive is seen to lose its isolated and empirical character, and acquire a history, and an intimate relation with all other branches of society's organized effort. It is lifted onto the plane of an intellectual achievement, and so offers a foundation upon which to erect ideals of a professional character.

The Outlook

A previous age witnessed the industrial revolution, which introduced the machine, and through it worked the entire reconstruction of society; now a second industrial revolution is in progress, which aims to lay a foundation of administrative principles underneath business practise, and which will inaugurate a new era of progress.

It lies within the power of this generation to end much of the drudgery and antagonism from which the operative classes suffer, by devising more just methods of partnership with the other factors in industry, and by harmonizing administrative methods with the requirements of human nature. It will be possible to unlock much of the energy of administrators, which is at present unused, because of the lack of an enthralling object of effort. It will be possible to raise the general tone of industry, by setting forth new ideals of efficiency, distributive justice and democracy.

THE PICTURE AND THE TEXT

By Professor ROBERT MACDOUGALL
NEW YORK UNIVERSITY

THE place of illustration in book-making is found to vary through a wide range of values as one reviews a series of volumes at haphazard. In some the pages are flooded with pictures, from thumb-nail sketches on the margins to full-page prints in the natural colors of the original; in others page succeeds page in unbroken letter-press, without an illustration from cover to cover. Here, too, the picture is a true illustration of the text it accompanies; there it has scarcely more relation to the contents of the page it fronts than the engraving on a drawing-room wall bears to the volumes that may lie on a table before it. The significance of the picture, as an illustration, varies as much as, let us say, the artistic merit of its execution; and its value in any individual case may lie anywhere between zero and ideal adequacy.

The reasons for such fluctuation in the employment of illustration are of course legitimate as well as illegitimate. In one case, illustration may be indispensable, in another, inadmissable; the book-maker, whether author or publisher, is guided by the nature of his subject. In general, the material dealt with must be picturable if illustration is to be practicable. Only a small part of what the mind deals with in representative thought is thus picturable, and reflection itself is but one of the many interests which life comprises. To be presented in this spatial and visible manner the subject must be both concrete and material. Not all such subject-matter, indeed, can be successfully represented; but to conform to the conditions of picture-making it must at least fulfill these requirements.

Much of our interest, both speculative and practical, falls outside this field of sensible reality. The relations and laws of things in the material world, for example, are abstractions which we formulate from the observation of a series of such individual concrete objects; and these abstractions, or generalizations, can not be represented pictorially, except figuratively, in a symbolic scheme. Such principles are aspects of the material world, though unpicturable; but there is another range of reality which does not offer itself to such treatment at all. Subjective experience has no sensible or representable content upon which to seize as the basis of an appeal to the eye. The absurdity of such a conception may be indicated by asking the shape of a thought, the color of anger, or the speed of a desire. When things belonging to this realm are writ-

ten of, some other phase of the reader's understanding must be appealed to than that of visual imagination.

If the elementary content of subjective reality be unpicturable, much less can its abstract aspects be rendered in spatial forms and relations. Thus scientific and logical analysis, explanation and philosophical reflection, and the whole literature of appreciation are debarred by the nature of their subject-matter from direct appeal through illustration. Works on logic and metaphysics—proverbially hard thinking—are rendered more unrelievedly so by the pages of close-packed type which follow one another in unbroken succession from beginning to end of the book. Yet it is just in such fields as this that illustration is most needed. Discussion of concrete things is readily apprehended by the ordinary mind, for it finds little difficulty in representing its substance in imagination; but to follow a process of abstract thought for any continuous period necessitates a more sustained act of attention and a mind disciplined by reflection. To make them generally comprehensible such abstract works imperatively demand illustration; and since a pictorial commentary is out of the question exposition must proceed by an exemplification of the concept or law to which the term illustration in its wider sense is of course commonly extended.

Pure science labors under the same difficulty as logic and metaphysics. The work of reflective thought, in all its forms alike, is to extract from a multitude of vivid but confusing facts some common type or law to which they conform, and the elaboration of norms and principles in this field is found by the average mind hardly less repellant than in philosophy itself. The process is laborious; it is insecure; it is unsubstantial. Works on pure science are not read as are those on experimental science and natural history, because their abstractness makes them more difficult; and the writer, especially if he appeal to a technical class of readers, feels that his concern is primarily in making clear the theory he is developing, together with its evidence—not in illustrating each aspect of it by concrete examples.

The limits of illustration and the function it logically performs thus involve a certain contradiction. Its availability and its desirability stand in inverse relations. Where it is least needed—that is, when the concrete things of the sensible world are dealt with, it is entirely feasible to introduce it; but where it is most needed—in facilitating apprehension of abstract conceptions, its use is practically impossible. There is therefore to be expected a surfeit of pictures in the one case and a dearth, if not a complete absence, of them in the other.

Within the field where pictorial illustration offers itself as an adjunct to literary treatment the further question arises of the relation which text and picture logically bear to one another, and the specific service which illustration renders to the reader. It may be assumed that the function is thus specific, and that text and picture theoretically form

parts of a single exposition. The crudest defect in illustration is a neglect of this fundamental requirement, yet it is a fault which has wide prevalence in certain forms of book-making to-day. A fixed amount of illustration per chapter, or hundred pages, is supposed to be expected by the reader, and an illustrator is engaged to furnish the required number of pictures. In the class of books where this custom prevails—for example, in light fiction—the quality of the demand for illustration falls to its lowest point. There is practically no situation the understanding of which requires visual exemplification. The story itself is commonly little more than a succession of pictures, each relatively simple and having a completely obvious relation to its neighbors. It is partly, at least, because the reader's demand is so far from exacting that such slight consideration is given to the really illustrative character of pictures in works of this class

When the primary function of the picture has thus lapsed, the reason for its introduction is to be sought elsewhere; for value of some kind it must possess if its introduction is not to be regarded as a sheer misconception of the reader's desire. This reason is to be found, it need hardly be said, in the mere decorative function of the picture. It is a trivial motive, which also ignores a fundamental canon of esthetics, yet one which has a distinct psychological value. It neglects the requirements of esthetics, for if the making of a book be treated as a work of art, everything which appears between its covers should be instrumental to the development of the central conception for which the work stands. No picture, from this point of view, is admissible which does not help—in the strictest sense, which is not indispensable—to make the meaning clear. But if the principle of function be neglected, a multitude of pictures may be introduced in a merely illustrative, as opposed to explanatory, way. One might, for example, insert the picture of a pen or inkstand each time the article was mentioned, though an acquaintance with these things on the part of the reader is fairly to be assumed. Such illustration of course has its place wherever the objects in question are unfamiliar and the reader is liable to construct in imagination a wrong representation of them.

Further, if the principle of unity be ignored the illustrations which are introduced may be chosen in virtue of any element of desirability which they possess. Value of this kind has a wholly indefinite range. It may be merely quantitative: so many pictures to so many pages of text; no bunching of illustrations in one part of the work while another is left bare; and the like. But such rules refer only to the distribution of pictures, not to their introduction itself. If illustration be not invariably an elucidation of the text, as it clearly is not, it must satisfy some other human need, or pictures would not then be found in books. One such motive has already been mentioned: the decorative sense. The picture satisfies an elementary esthetic demand. It is introduced as the

picture is placed on the wall, because it has a beauty in itself. An illustrated book is more attractive to casual inspection than one which lacks such an adjunct. One likes to look at pictures even when dissociated from sustained interest and lacking a common thread of connection. The occupation makes little demand upon mental energy and is accompanied by a sense of ease, while the vivid or novel aspects of the world which are passed in review give rise to a pleasurable state of consciousness through the mild and equitable stimulation which they afford.

The picture thus becomes in a way correlative with the text, each adding an independent element of value to the whole. Within its own field each then seeks a characteristic excellence, and a set of canons is developed in regard to the making of such illustrations. In the first place, they are enriched in their positive values as pictures. They must be well composed and correctly drawn; they must have vigor and refinement in their execution; if colored, the tones must have splendor and harmony; and so on. In the second place, as in literary art dignity in the surroundings, noble birth, beauty and virtue in the characters are invoked to deepen the impression, so in this use of book-illustration the backgrounds must be rich, the scenery beautiful, the figures of either dignified age or noble youth. The men are all handsome, according to the illustrator's individual conception of good looks, the women in a like manner beautiful; the dress worn is irreproachable in fit and of the latest pattern. All the accessories of success, luxury and style reinforce the more direct values of health, vigorous action and beauty. Or, if this special class of effects be not involved, the esthetic appeal is still to some equally general and elementary sense, such as that of romantic pity in which a certain stereotyped pathos affords the underlying motive of treatment.

The illustrations, in such a case, become a gallery of pictures by a single artist who commonly emphasizes, in a highly conventional way, a particular style of treatment or specific human type. When such an illustrator has achieved a vogue his work is likely to be sought by publishers for the meretricious excellence of these features, however poor his illustrative capacity may be.

The high degree of mechanical development which process reproduction has attained tends to foster this use of illustration. One can not imagine a book overloaded with mere diagrams which in no way help in the elucidation of the text, for such drawings have no other value which can be substituted for this primary service. So long also as the illustrator's art is crude, or the process of reproduction difficult and expensive, pictures will be introduced only where there is an evident purpose to be served, and little abuse of illustration will arise. Photographic, chromo-lithographic and other processes, however, have made possible such a high degree of success in transferring to a prepared surface of

paper the features of the original in all their refinement of details and values that to look on the reproduction in a book is now comparable with looking on the scene or composition itself. The result has been a still further widening of the breach between text and illustration; and the temptation must often be great to introduce a picture because it is good in subject and admirably reproduced, though in its composition little regard has been paid to the situation which it is intended to represent. This defect is no less noticeable in the flotsam of periodical literature and the daily press than in the more elaborate composition of book-illustrations. When pictures are looked for, pictures will be forthcoming, whether appropriate or not. The waste corners of the newspaper are often filled with odds and ends of wit, humor and anecdote, in which the union of text and illustration too often suggests that the items have been thrown together and then drawn forth in pairs at haphazard.

The significance of such variations in the place of illustration, as well as the factors in their production, will perhaps be more clearly apprehended if the changes of value which the picture undergoes in individual mental development are recalled. In adult literature the text has complete meaning in itself, the picture has not; the text is made first, then the picture is composed; for the latter aims simply to present in a concrete visual image what has been set forth through verbal analysis in the text. The picture is thus completely subordinate to the text; it serves only to reinforce a feeble visual imagination in its effort to get before the mind a scene which the writer of necessity presents in fragments by successive statements.

But this is not the primitive way of conceiving the relation between these two constituents, nor is it the association which at first existed for the child. The picture, in those earliest days, was primary, the text secondary. For the adult the picture illustrates the text; for the young child the text explains the picture—it is needful only in case the picture can not be understood by itself. The text marks the imperfection of the picture, or series of pictures, in telling a story, and is added to supplement its deficiencies.

Pictures have a meaning for the child long before he begins to read or understand printed words. From babyhood they form part of his perennial delights, and are among the most treasured of his sources of pleasure. They have splendor of color and never-failing variety of forms; they represent objects of enduring interest, whether familiar or novel; they are full of action or suggestive of manifold and significant relationships; they tell, singly or in series, stories vivid and direct in their appeal, which are made scarcely the less alluring by their partial incomprehensibility.

The appreciation of pictures is a part of the child's introduction to language and representative thought. They have something of the controllability of images and, except for motion, the vividness and natural-

ness of real objects. Through them the absent world is brought back, each picture affording the point of departure for a supplementary imaginative process which grows richer and richer as the years pass. Pictures thus form a natural mode of transition from the intuition of the world to its representation in thought by means of the conventional symbols of written language.

In primitive peoples as well as in the life of the child the line of development is through pictorial representation of reality to its description in analytic terms by means of verbal symbols. The evolution of language is marked by an increasing importance in the rôle played by the explanatory text and a corresponding decline in the use made of pictures. In the stages of barbaric culture picture and text are habitually associated. Vast series of figures, on temple wall and tomb and tablet, represent the scenes and events to be recorded, while beneath or at the side is put the running commentary of lettering or other text—the text itself commonly a modified picture-series, as in hieroglyphs and ideographs. Among civilized peoples the picture drops back to a purely accessory position. The text is now completely intelligible by itself—at least it aims to be so; while the introduction of pictures either marks a sense of insufficiency in the verbal medium or reflects purely an appeal to esthetic values.

The child, if not the barbarian, apprehends and employs pictures in a way different from the adult, as regards their relation both to the text and to other pictures. This difference marks a characteristic distinction between the two mental types; for the individual's conception of illustration and its function reflects from year to year the nature and development of the mind. At any moment the child will be interested in those pictures which appeal to the needs and impulses then dominant, and at each successive stage of his history only such as conform to the conditions and limitations of his mind will be intelligible. If a picture exhibit the complex relations of many component figures it will not be appreciated by a mind incapable of apprehending the synthetic unity of a complex group or multitude; and if it represent a single phase in such a connected system of actions or events as can be presented only in a series of pictures, it can not be apprehended by a mind that lacks the capacity to seize their unity in a dramatic concept and thus in imagination to construe the successive elements as a single action.

For such a mind the complex composition will exist only as a multitude of separate figures, among which indeed the mind may wander renewing its delight as each attracts attention, but which receive no added significance through their synthesis as members of a common system. The various pictures which represent the successive phases of a dramatic action will likewise be apprehended only in isolation from one another, each being treated as a story or situation in itself or, if the mind

be elementary enough, as a mere collection of individual figures and objects.

The way one expresses himself in pictures or writing, and the way one interprets illustration or text, thus reflects the level of organization which the mind itself has reached. The single figure, the composition, the pictorial series and the textual description mark successive stages in the evolution of representative functions in the individual human mind. The child passes through each of these stages in turn as he advances toward maturity in synthetic thought, and a customary dependence upon any given type fixes the developmental level which has then been reached.

The aim of education in this regard is to develop in the individual a capacity to represent experience and to express thought adequately through a system of analytic and verbal symbols. It seeks also an ability to translate these symbols fluently into terms of significant thought when they are thus employed by others and to create imaginatively the forms of original experience which they are designed to describe. It marks an arrest of development in the mind not to be thus a master of words, whether in their use or their understanding. To need pictures in order to make the thought plain means either that the writer has not mastered his craft thoroughly and does not know how to use his tools, or that the reader's mind is immature or has momentarily lapsed from the habits which characterize maturity.

The child's love of pictures obviously persists in adult life; it is eradicated in few, if any, natures and to their distinct loss. We, as well as they, on taking up a book, often look first to see the pictures, and turn to the text only when the illustrations have been explored. The pictures are a mental appetizer which whets our appetite to a keener edge as we approach the solid courses of the printed page. How often, too, when we are tired or disinclined for strenuous mental effort, do we explore the pictures of an illustrated book or magazine, which can be understood and enjoyed without exertion! It is not only at such moments of intellectual idling, however, that we thus turn to pictures in connection with our reading. How often, when a point of difficulty arises do we long for a pictorial representation which would make all plain to us, as by a flash of lightning the dark landscape is revealed at night! How gratefully do we turn to a satisfactory illustration and find there the realization of our own conception which the artist has made still more rich and splendid by his craft! And when the subject matter is such as to put our logical reflection under severe or continuous strain, how constantly do we have recourse to the device of tabulating or schematizing the substance of discussion in some spatial way that shall present it concretely and visibly!

Illustration has thus a distinct and important place in literature. The use of pictures is twofold—they serve understanding and they increase enjoyment. In the latter case, however, they are not, in the

proper sense, part of the discussion which they accompany, but form an independent source of value. Their service to the understanding is also twofold— they make clear to us relations too complex to be successfully conveyed by words, or conveyable only at inordinate length. Of this class of pictures the spatial diagram is typical. Their second function is to bring before us a scene whose splendor and richness can not be successfully represented in imagination. The latter bears to material content the relation which explanatory diagrams sustain to formal synthesis. Pictures of buildings and natural scenery, of the human figure and organic forms at large, indeed all concrete objects which are either unfamiliar or present subtle complications and gradations of quality, fall within this category.

While pictures have their own distinct place in literature, they can not be substituted for the textual description in any degree without affecting the place of the whole composition in the evolutionary scale. Language sets as its ideal the development of an adequate system of symbols for the representation of experience. The spoken sentence has fulfilled its function only when, through its own elements and syntactical form alone, it has adequately expressed the content of meaning intended by him who utters it. Writing is a transliteration of speech, and merely substitutes another medium in its performance of the same ideal office. Each in its own field aims at the development of a pure system of symbols, that is, a system which without accessories is capable of indicating the whole range of distinctions with which thought is concerned. Among civilized peoples both speech and writing approach adequacy in this regard, but in so far as pantomime persists in the one case, or illustration is relied on in the other, it marks a deficiency in the medium. In its ideal form language should no more depend upon gestures and pictures than upon the presence of the original objects and relations themselves which it seeks to represent through conceptual forms.

One has mastered the uses of language only when he is able to make a continuous translation of experience into its symbols and, with a similar facility, to interpret these signs in terms of their ideal meanings. In writing, then, such mastery is attained when adequacy in the expression of thought has been secured without any recourse to pictures, diagrams, models or objects. It is part of the mental training at which a cultivation of language aims to render the mind so far as possible independent of pictorial or other concrete ways of presenting the materials with which discourse deals. Like the use of the abacus in numbering, these aids may be indispensable in certain forms and at particular stages of development, but they must be superseded if any high degree of attainment is to be secured

Language will doubtless always fall short of this ideal aim. Speech will continue to be made more picturesque as well as intelligible by gesture, and illustration will enrich while it illuminates the printed page.

Nevertheless to make use of a picture where a verbal description can be given is to fall back upon a more primitive mode of representing experience, and the tendency to do so marks a degeneration either in the mental habits of those who employ such methods or on the part of the readers to whom they are addressed.

The function of the picture, in a certain large class of writings, has recently been undergoing change, and the direction of this modification seems to indicate a loss of intellectual fiber in the commonalty of readers. The present day is marked by an enormous increase in the amount of illustration which accompanies the text we read. In our books no less than in the daily press, in what is written for adults equally with what is prepared for children, in technical journals and scientific monographs as well as in popular magazines, this progressive encroachment of picture upon text is apparent. The newspaper strives for illustration in connection with all classes of news, and its staff of photographers rivals the corps of reporters in numbers and importance. Every page has its pictures, and even the gist of editorial comment is sometimes indicated by thumb-nail sketches used as paragraph-spacing.

It is probably materially true—and if so it is a significant fact—that the cheaper the journal the greater the amount of space given to pictorial matter. In such cases the aim seems often to make the story intelligible by means of pictures alone, with only secondary dependence upon the text. The appeal to pictorial representation in this way includes an immensely greater range of cases than newspaper and magazine illustration; and in this larger field its uses are of course legitimate as well as vicious. When we advertise, everything which can be represented is pictured within a frame of type or spread upon the poster, the fences and the farm-buildings. When we go abroad, our correspondence no longer takes the form of twelve-page letters, but that of a dozen picture post-cards. Our records of travel do not consist in a description of places and people or a dramatic recital of events, but in a gallery of representations of cities and buildings, of landscapes and portraits. We never describe a thing if we can procure a photograph of it; for writing an account of any occurrence—though it presents phases of the event which no picture can ever convey—is difficult and time-consuming.

Our popular magazines no longer depend upon the excellence of their literary contributions as their sole claim upon attention, but are filled with varied and mechanically admirable pictures. With the increasing dependence upon illustration the value of the text has correspondingly declined. In cheaper periodicals the contents are not uncommonly reduced to a group of departments—travel and places, the drama, celebrities, oddities, jokes—in each of which the substance is largely composed of detached pictures with minor explanatory comment. How far this demoralization has gone is indicated by the character of the text in such periodicals; for where it is not a mere commentary on the illustrations

it is still commonly a scrap-work—of information, humor, anecdote, etc., with the sketch or short story as the climax of its demands upon synthetic thought.

The mere change in average length of article which, with a few striking exceptions, has steadily declined during the past generation, is suggestive of this alteration of attitude; and the rise of the short story to a dominant place in our popular magazines is probably part of the same intellectual reaction. We seem no longer to desire sustained attention and consecutive thought. As a consequence we turn from criticism, reflection upon human affairs and constructive theory to fiction, which as a class of literature presents its materials concretely and pictorially; while in fiction itself we prefer the short story, which must deal with a single dramatic action or situation, rather than the novel with its more complex plot and sustained analysis of character and motive.

Lapsing still further, we demand that our intellectual food shall be put up in the form of mouthfuls, or boluses, in notes of travel, places, events; in anecdote, verse, personalia and the like; until each page of the publication exists in practical isolation from the rest. In such connection "mental pabulum" is a misnomer. No real intellectual stimulation, enlightenment or discipline enters into the case. Mental activity is practically limited to the pleasurable sensation of the moment. Reading becomes a stimulant, not in the sense of arousing a heightened intellectual functioning, but only in its provoking a momentary excitement of the imagination; and the mental content of the reader is reduced to a series of such crudely exhilarating moments, unprovocative of subsequent reflection and without any enduring illumination of mind. One who falls into such a habit has become an intellectual drug-fiend, for the securing by artificial means of a heightened or quieted consciousness is not restricted to the use of the needle and the pipe alone. It is a matter of common experience that we turn from the editorial page and critical discussion to more trivial and inconsequential items as the mental energies flag, and for many of us the approach of exhaustion is marked by an assiduous and almost involuntary reading of the advertising columns of our daily paper. Men of intellectual force have similarly confessed to a habit of devouring shilling shockers when tired from a long bout of work, the jaded mind still craving an activity which it was unable to sustain and finding satisfaction in the violent stimulation and elementary situations which yellow-back literature offered.

The significance of certain changes in the place of illustration to which attention has already been called in the case of books and periodicals is still more strikingly exhibited in the recent history of platform speaking. The public lecture has been an important factor in the development of American culture. Before the multiplication of periodical literature and the rise of the illustrated magazine its position was supreme. Upon the system of Lyceum lecturing the intelligent public

largely depended for the dissemination of general knowledge as well as for the presentation of social and political problems. It afforded an almost ideal method of developing a vigorous and independent public opinion through the stimulation of reflection and discussion. The limitations of opportunity which made the lecture course a characteristic form of entertainment in New England during the greater part of the nineteenth century had the fortunate effect of fostering an appreciation of good thinking and a demand for it in public speakers. By intellectualizing amusement it stimulated the habit of criticism, and through the inducements it offered to scholars and thinkers of the first rank it secured the spread of philosophical ideas and helped to sustain general interest in public questions.

One has only to contrast with all this the popular lecture of to-day to realize how far we have traveled from these earlier intellectual preoccupations. Leaving out of question the field of political discussion, which has had an unlike as well as independent development, and limiting consideration to matters of common interest, to general information and culture, science, art, literature and philosophy—the transformation will not only be found radical, but will be seen to follow a course parallel to that which has been traced in magazine and book-making. Dependence is no longer upon the substance of what is presented alone; in many cases it has not even chief place. In lyceum days the lecturer relied upon his own resources. Success and failure turned upon the question of his ability alone; there was no dispersion of responsibility. Except for rhetoric and wit he had no means of tricking out his wares. There was no second line of defences to fall back upon; for his discussion of art was not illustrated with music and Greek dances, nor his lecture on natural history supplemented by lantern slides and moving pictures. What the speaker had to say was all that counted, and it is only when audience and lecturer stand in this direct relation that the intellectual quality of public speaking can be sustained.

That it has not been sustained is beyond question, and its decline is closely associated with the increased use of pictures. Practically all popular lectures are now illustrated. One scarcely dares come on the platform alone or in full light; whatever one's subject, the text must be supplemented by pictures. If a human life is to be studied, not only are portraits secured, but pictures of parents, birthplace, and associates, copies of autographs and human documents of all kinds. If history is to be discussed, archives and museums are similarly ransacked for illustrative materials which are reproduced upon the screen. If countries are to be described, their physical features, cities, monuments, architecture, dress, customs and industries are pictured; and an exhibit of natives in their national garb as well as of their implements and products is not infrequently brought upon the stage.

All this, in the first place, has of course added an extraordinary richness and definition to our imaginative representation of the distant and unseen. Places and persons, forms of life and manufacturing processes are thus brought actually before our vision, if not before our senses, in their completeness. We are made familiar in advance with things which are to be seen only later in life, if at all; and our sympathetic participation in affairs at large is deepened as well as broadened. The greater world must be brought to the individual through the imagination if he is to come into contact with it at all, and pictorial representation vitalizes and reinforces this sense of understanding and community with mankind.

In more specific relations the picture-supplement facilitates our understanding, and this service has made it indispensable in bringing before the mind objects or processes whose constitution is too complex to be presented analytically, or to be reconstructed from a purely verbal description. In the lecture, just as in the book, illustration has a place not only legitimate, but important. Comprehension begins in intuition, and our sense of security in any general conception is weakened in proportion to the vagueness which marks our mental picture of its field. So long as photographs, stereopticon views and moving pictures perform this service, their use by the platform lecturer must be welcomed. Nevertheless, their function is a distinctly subordinate one—namely, the illustration of a theme which is itself still the essential preoccupation of the mind.

This relation has now significantly altered; the picture is advanced to the front rank and the theme has correspondingly fallen back. The very relation of speaker and screen in the illustrated lecture symbolizes this change. The lecturer stands in an obliterating shadow while all the energy of illumination is concentrated upon the stereopticon sheet. Even in its most elementary physical relations the focus of attention is thus shifted, and the change is significant of a profound modification in the relations of audience and lecturer. Language is an appeal to the mind, not to the eye; and its function is imperiled whenever this fact is obscured. The focusing of vision plays an important part in maintaining this intimate spiritual contact, and nothing more effectual in destroying it can well be conceived than the substitution of another point of regard so violent and alluring as the illuminated screen.

The extraordinary mechanical perfection of photography, its extension into the fields of panoramic, telescopic and micro-photography, and above all the development of motion pictures, have accelerated this adoption of a new attitude and the creation of a novel demand on the part of the audience. For one does not merely introduce a new medium in substituting pictures for discourse; the appeal is to a different side of human nature and satisfies an independent craving. Confronting facts

is different from understanding them. Merely to go into the fields is not to study botany, and unless we carry that definite aim with us the stroll is much more likely to add to our dumb enjoyment than to extend our knowledge. The eye may be filled while the mind is left untouched; for it is just when sense is thus completely satisfied that reflection is most likely to lie unstirred.

The vogue of illustration, as an adjunct of public lecturing, marks such a change of habitual attitude. We go to the lecture, as to the theater, to be entertained, not to be instructed; and are so absorbed in looking that we cease to think. A swift succession of vivid impressions, resplendent in color or palpitating with motion, passes before the gaze. There is as little leisure for reflection as directive stimulation to thought. The senses are stimulated and at last jaded, as picture succeeds picture and topic replaces topic; until, breathless with the dizzying rush of scenes, we are at last tossed back, momentarily bewildered, into normal relations with the world about us.

Under such conditions the verbal commentary of the lecturer becomes a matter of secondary importance, and we accept a mediocrity of merit, or even a literal incoherence, which would never have been tolerated under the more exacting conditions of the lyceum. Indeed, if the pictures be only chosen skilfully enough the text may be rendered wholly negligible, as the kinetoscopic theater indicates by its elimination. In a word, the speaker has been replaced by the picture-machine, and a corresponding change in our conceptions of merit has accompanied the substitution. We require better and ever better pictures and promote a race for mechanical perfection. We stimulate the ingenuity of inventors to devise fresh marvels of reproduction; color is added to form, and motion to color; but still we demand more. The world is ransacked for its treasures of picturesqueness or beauty, and men's brains racked to conceive new dramas and burlesques of action. As a result these pictorial and esthetic demands finally supersede the lecturer's original function of interpretation.

This trend has perhaps been most striking where it has been least justifiable, in connection with the presentation of scientific materials. The change is at least suggested in the subordination of theoretical to experimental and demonstration methods in teaching. The aim of scientific instruction is to put the mind in possession of a system of explanatory concepts. These are necessarily abstract and can not be set forth in the form of concrete examples. There is therefore a danger that attention, detained by its purely picturesque aspects, may recall the demonstration merely as an impressive spectacle, and thus lose sight of the principles which it illustrates. The use of demonstration methods in the class-room, however, presents less subversion of aim than that of platform illustration. The lantern-slide has won a secure place in the tech-

nique of instruction, within the school system as well as beyond it, and it is only its abuses that are to be deplored. But these have not only crept into the rapidly growing extra-mural work of higher institutions, but even pervade the programs of scientific societies themselves.

With the preferences of an audience which confessedly seeks entertainment one can not well quarrel on the ground that it ought to desire instruction instead; one can only note the appearance of new predilections in the social habits of a people. But against an institution devoted to the advancement of knowledge, or the fostering of an interest in science, protest lodges whenever these aims are lost sight of or subordinated. The past decade has seen a rapidly growing tendency on the part of such societies to allow the presentation of purely illustrative materials to trespass upon the formal discussion of their common subject matter. The change is one which affects the very ideals for which these bodies stand. The science of geology, for example, has perfectly definite aims which are not attained by the photographic reproduction, however copious or admirable, of rock strata and erosion effects, of talus slopes and detritus, of shifts, faults, dykes and lava-flow—though an acquaintance with all these things is essential to the prosecution of its general undertaking. The science of geography, likewise, is no more adequately represented in the flood of charming pictures to which we have grown accustomed in periodicals and platform lectures alike than is a knowledge of the development of any people embodied in the impressions one carries away from those ingenious pageants to which—still as picture lovers—we are turning with equal enthusiasm in the field of history.

In public lecturing and the methods of instruction, as in magazine and book-making, these phenomena have a common significance. They indicate a change in the point of support on which the speaker rests, as well as in the nature of his appeal to the hearer. The new demand is not less strenuous than the old, but it is of a different kind. Instead of requiring a definite constructive activity, stimulated and directed—but never supplanted—by the mind of the speaker, it titillates the imagination with a series of agreeable shocks. The mind is not taxed but appeased; the soi-disant teacher exerts himself to anticipate the moment of flagging attention, and out of an abundant store to supply it at each turn with a novel and pleasurable stimulus. Education and discipline are not attainable by any such process. It is only by thinking that knowledge comes, and thought is a function that can neither be assumed by a deputy nor taken over by any other faculty. Instruction and entertainment, though equally essential to human life, can not be confused as specific aims without the sacrifice of their several values. Every normal individual resents the instruction that is disguised as entertainment; but the ultimate effects of a systematic pretense that entertainment is instruction are no less to be feared.

DETERMINING EDUCATIONAL VALUES

By Professor M. V. O'SHEA
UNIVERSITY OF WISCONSIN

IT will probably not be questioned by any one that the most complex business society can undertake is to train the rising generation effectively. The human mind is an extremely complicated thing. It is so intricate, indeed, that it has been found impossible thus far to discern many of the laws according to which it evolves and functions. "What a marvelous piece of work is man," expresses the feeling of the poet as well as the view of the student of any phase of human nature. The problem of preparing a child for happy and effective adjustment to the world in which he must live is immeasurably more difficult than the hardest engineering problem, say, which men in any age have yet undertaken. The engineer has only to deal with physical laws, which are relatively simple and easily determined as compared with the laws governing mental activity and efficient mental development. The engineer is usually able to ascertain whether or not he has correctly apprehended and dealt with any law of nature. At every step he can control his work, because the effects of his action are immediately measurable. But it is entirely different with the educator. He can not directly measure the outcome of his methods. Most of his training produces noticeable effects only after a long lapse of time, and then only in an obscure and entangled manner. Any one, then, whose duty it is actually to mould a human mind according to the most desirable pattern, and who realizes the complexity of his task, is apt to be more or less awed and even mystified by his problem.

But the man on the street, looking at the business from the outside, is apt not to feel much mystery about it. The whole matter is likely to seem clear and simple to him. He can dash into his office, and in a few minutes give instructions how to deal with problems which are probably inscrutable to one who for years has been seriously trying to solve them with due regard to all the factors involved. The tendency of the non-expert in any field is to resist the idea that he is incompetent to form an opinion about matters in that field. Witness how the layman and even the drug doctor have ridiculed the theory that disease is largely of bacterial origin. It is the same way with legislation. The layman proposes to solve social ills by some simple, drastic legislation. He resists taking the point of view that social relations are extremely complex, and that the new difficulties which arise with the increasing

complexity of society demand more and more subtle forms of treatment, in order to cause justice to prevail among men, and at the same time not to arrest the evolution of society.

The layman usually feels more confident to give advice regarding education than he does regarding medicine or legislation or even religion; and this is the chief cause of the vast amount of conflict over teaching in these days. Those who are working on the inside, who may be said to have the expert point of view, are introducing changes in courses of study, in the methods of presenting subjects, and in the modes of organizing and conducting school systems, which they think are demanded in order to meet the changing conditions in the social organism. New subjects are being added in the belief that they are essential in order to give the pupil an appreciation of contemporary life. It is seen that the conditions for which the school must prepare its pupils are very different to-day from what they were fifty years ago; though the layman sometimes indicates his view of educational policy by saying that "the little red school house produced the greatest men the world has yet seen; and why not let good enough alone." He apparently does not consider that these men may have attained their greatness in spite of, or at least independent of, the school. As a matter of fact, some of the most distinguished of these men were self-taught.

The man immersed in affairs in his own field is apt not to take account of the fact that knowledge, practical knowledge, is rapidly increasing in many fields which were hardly opened up fifty years ago. Everything affecting human welfare is becoming more complex; and even if a relatively simple school régime a half-century ago was adapted to the needs of men in those days, such a régime might be entirely unsuited to the conditions of to-day. The student of education sees what has happened to society in the countries of the old world in which the school has kept to the simple, traditional curriculum. The pupils come out of the schools in such places quite unaware of much that exists in the world to-day, and they are unable to cope with modern conditions as created by progressive nations. If the advice of a large proportion of the lay and non-expert critics of the schools should be followed, it is as certain as anything can be that we should in a brief time, as such things go, come to an arrest in our development, much like that to be observed in Italy or Spain at the present time.

Of all the fault-finding regarding contemporary education, the most persistent is that which charges the schools with devoting much of their time and energy to "fads" and "notions." It is probable that some at least of those who write this criticism have never been inside a modern school building, and they doubtless have but a very imperfect conception of the principles underlying the evolution which is taking place in the curriculum, and in methods of teaching. Such men are apt to pose as authorities on every subject engaging the attention of people. They

know they can strike a more or less popular chord when they denounce prevailing tendencies in teaching, so they ridicule prevailing methods and praise those of bygone days. It has become a sort of fashion now for certain newspapers, when they find themselves short of other material, to run something on "fads and frills in the schools."

Recently an editor printed a series of articles on the schools in a western city. He said they were being "honeycombed with fads and notions." When asked to name a conspicuous "fad" in the schools, he replied with general statements, but without hitting the mark once in his criticisms. He was asked whether the teaching of history was a "fad." "Of course not," he said. "Is the reading of English classics a 'frill'?" "No." "Or the teaching of children to sing a few minutes every day?" "This is all right, too." "Is it a 'notion' to teach them to express themselves through drawing?" He thought this was proper for most children, at any rate. "Is it wrong to have some memorizing of literary gems every day?" "No, this should be practised more than it is." "Where then are the 'fads?'" Apparently he realized he was in a tight place; and yet it was impossible to keep him from declaiming on the more thorough teaching of spelling, arithmetic, etc. The fact is this man, and there are others like him, had only a vague knowledge of the thing he was writing about. Unfortunately this writing tends to corrupt the minds of the people, and so to render it all the more difficult to secure educational evolution in response to the demands of the times.

It ought to be said at this point that the majority of laymen and a good proportion of teachers do not view the subject of educational values in any critical way whatever. The very fact that grammar, say, has been long taught in the elementary school is a sufficient guarantee for such people of its superior worth, and especially since they were taught the subject themselves. Most people settle the question of values in education much as they settle any problem of dress or of household management—they consider that to be right and best which is in general practcise, and which they have been accustomed to themselves. As a rule, though not always, the non-expert in education (and the principle holds for other interests) is conservative. He dislikes reform in studies or methods, because he can keep himself better adapted to a permanent and stable than to a changing order of things. However, this is not likely to be true in respect to the particular interest in which he is most vitally concerned, as in manufacturing, say, where the keenest sort of competition makes him realize that if he does not alter his methods to meet new conditions he will be crushed by his competitors. Keen necessity makes him dynamic, aggressive, radical. But in all those interests which he touches only incidentally, as it were, in which he does not feel serious competition, he often seems incapable of appreciating that progress is necessary, or even desirable. So in edu-

cation, as in hygiene, religion, politics, etc., we must expect that the majority of people who have not become particularly interested in the business will vote to have things continued as they have been, or as they now are. They will resist innovations. They will cry, "Fads!" "Frills!" etc., whenever any new topic gains a foothold in the curriculum, though they may be progressive enough in their own special field, where they can appreciate the value of new methods suited to contemporary needs.

The diversity of opinion regarding values in education, to which attention has been called above, suggests that laymen as well as teachers must look at the matter involved from different points of view. The writer has asked individuals and groups in many sections of our own country, and some of the countries across the sea, what they consider the proper standards in determining the value of any study, or any method of teaching, or any principle of discipline; and the responses have impressed the fact that there is no universal mode of appraising values, which is adopted by laymen in deciding any educational problem. Some persons say that a study is valuable in the measure that it confers "culture" upon the one who pursues it. Other persons say that the true value of any educative material depends upon the extent to which it trains the mind. Still others feel that no study is of worth which does not contribute to the individual's efficiency in practical life.

All sorts of figures of speech are used by people in striving to express their conception of the nature of mind and the function of education. The present writer has heard the remark made time and again that what we must do in the schools is to "strengthen the faculties"; or we must "polish" the mind, for until it has been so treated it is like a "rough diamond," or we must "cultivate" it as we would a field, in order that it may become "fertile"; or the subjects of study should "nourish" the mind, as food nourishes the body; or we should "sharpen" the faculties as we would sharpen an edged tool. The list of figures of speech based on physical objects and phenomena and used to describe educational work might be extended almost *ad libitum*. The mind is so subtle and complex that we endeavor to make our thinking about it definite and concrete by ascribing to it, at least for purposes of definition, physical properties and characteristics. And individuals as well as communities tend to employ the physical conceptions most familiar to them in their reactions upon their own environment. People who live on the sea will employ figures of speech different from those who live in the mountains or on the prairies or in the city. The mechanic will draw his figures of speech from his particular work, and the same will be true of the miner or the merchant or the woodsman.

Let one ask the people whom he meets on the street, in the reception hall, or in academic halls, what effect the mastering of arith-

metic, say, has upon the mind of the one who assimilates it. The majority of the responses he receives will be based upon an argument something like this: Arithmetic is an exact science; everything in it can be definitely proved; accuracy is absolutely essential in resolving arithmetical problems; therefore, the pupil who learns arithmetic will be trained in accuracy of thinking more thoroughly than he could be in assimilating history or geography or music. And since accurate thinking is the first requirement for success in life, it follows that this subject constitutes the most valuable study in the curriculum. People who reason about education in this manner will assign to algebra, geometry, trigonometry and other branches of mathematics the first place in the high-school curriculum, because they are all concerned with principles which are apparently exact; and *the learner takes on the quality of the material which he learns.* Those who proceed in this manner in determining values do not think it needful to observe whether, even if a pupil in assimilating algebra is trained to be accurate in his thinking, this kind of accuracy is of service to him in the practical situations of every-day life.

If one will examine the opinions of lay writers on teaching since Plato's day, he will find that many of them have regarded the materials and the methods of education in a purely *a priori* manner. They have analyzed the matter of any subject of study, as mathematics, and they have naïvely inferred that the properties of any special material, viewed objectively, will be grafted on to the mind and character of the individual who masters it. Take, for instance, the view held by some older writers, that it is debasing to study what is to-day called natural science, because of the baseness of physical objects; one who studies these things will take on their qualities. On the other hand, if the individual in his education is made to learn things that relate to the spirit, he will become more highly spiritualized. Persons who gain their notions in this manner do not think it necessary actually to observe what effect the study of any subject has upon an individual, whether as a fact it exalts him spiritually or debases him; whether it makes him more of a friend to his fellows or cultivates unsocial and selfish attitudes. He *infers* that a certain result *must* follow from the study of any branch, because of the nature of the material learned.

This logical, analytic method is the popular one in use among laymen and among some teachers to-day, as it has been in all times. It is in principle like the method which has been followed heretofore in the study of values in nutrition. The older nutritionists worked out tables of food values based entirely on chemical analyses of different articles. They said, to cite a typical instance, "Cheese contains 70 per cent. of albumen; albumen is an essential element in nutrition; therefore cheese constitutes a valuable food." These analysts went through with all the articles of food in order to determine their chemical constituents;

and then they assigned them to a place in the scale of values according to the results of this analysis. They did not think it imperative to observe whether or not the organism would easily and economically assimilate any particular food, or whether the factor of appetency should be taken account of. They did not inquire whether there were elements in cheese, say, which the organism might resent, so that instead of this being a good article of food it might be nearer a poison.

We seem to-day to be abandoning the practise of relying wholly upon the analytic method of determining food values. We are now attaching chief importance to observing how the organism reacts upon any article of food when it is taken into the system. This method is likely to modify greatly our conception of food values. It is of special significance for our purpose that it seems already to have been shown that an article of food which may be of great service to the organism at one period of its development may be relatively valueless or positively detrimental at another period. It has been shown, for example, that while a calf may thrive on milk during the first months of its life, still if it be kept on a milk diet too long it will begin to decline, and it will literally starve unless other foods are added to the dietary. But the chemical methods of determining the values of foods make out milk to be a valuable food without regard to age or individual differences.

The principle under consideration can be illustrated further by referring to the methods employed in an earlier day in the study of the parts of speech in children's language. Men like Hale and others wrote down the words an eighteen-months old child, say, used in his daily expressions. Then they went to work and classified these words according to their grammatical properties, so that they found that 60 per cent. of the words a child used were nouns, 20 per cent. were adjectives, and so on. Then they inferred that the child's thought relates mainly to objects as contrasted with actions, and qualities, and spacial relations, since nouns predominate in his vocabulary, and they denote things. But to-day we appreciate that the outward form of a word does not furnish clear evidence of the way it functions in the child's expression. He may use the word "cat," say, with verbal, adjectival, and exclamatory as well as pure nominal function. That is to say, the fact that "cat" is grammatically a noun does not show that the child employs it as such. Indeed, it is certain that at the outset he does not use it with strict nominal function. The only effective way to determine the parts of speech in a child's vocabulary, viewing the matter from the standpoint of the *function* of words in expressing thought, is to observe the child as he reacts upon his environments when he uses particular words, so that we may notice what his attitudes are when he employs them.

This principle is mentioned here simply to impress it as of special importance in application to the study of educational values. In order

to determine these values in any effective way, we must take account not only of particular subjects and methods of instruction, but we must keep in view especially how the individual reacts upon these materials when they are presented to him according to different methods and what effect they have on his activities.

Manifestly, in the present light of our knowledge on the subject, one can not speak with certainty regarding much of the material of education. The factors determining efficiency in adjustment are too complex and involved to permit of detailed analysis, and the function of each definitely estimated. While the pupil is in school he is also in the home and on the street. He is having much experience for which the school is not in any way responsible; though it has been the common practise in discussing values to ignore all experience except that gained within the school. One frequently sees persons who naïvely infer that whatever ability they possess in using arithmetic, say, in daily life, was gained in the school; but it is easily possible that most if not all of it was developed through the necessity of dealing with real situations outside of the school. In the same way, they maintain that their skill and efficiency in the use of the English language was developed through the study of grammar in the school, whereas it is probable that their linguistic ability is due mainly to the give-and-take of life in the home, and in the other real situations of life.

But while one can not assume a dogmatic attitude in the discussion of these problems to-day, nevertheless one may proceed in confidence upon the proposition that the individual will be benefited in school education only to the extent that the sort of experience he has in the school is the same kind as that which he will have outside in adjusting himself to the conditions of daily life. This means that in respect to the material of education, and also to some extent to the method of teaching, there must be diversity depending upon sex, upon existing social conditions, and particularly upon the sphere of life in which individuals will be placed. For a child being trained in Italy, say, any given subject would be likely to have a somewhat different value from what it would have for a child being trained in America. It is impossible then to say what the value of any special subject or method is until one knows what the needs of the pupils are. Of course, in any given country at any particular time individuals can be grouped into classes, all the members of which will have substantially the same needs; and the needs of any one member will be ministered to effectively if he has the experiences which will work out well for the group to which he belongs. His individual needs may not be provided for in every detail; but there will not be much waste in his case provided that the general needs of the group are adequately met. In a dynamic, developing social organism, there will be constant differentiation among individuals, so that for some members new needs will be arising which will

not be fully taken care of if they are confined to what is essential for the group as a whole. This implies that in any plastic society the number of groups which must be provided for in the school will be constantly enlarging as society grows more complex and new forms of social service are required.

So one who attempts to estimate educational values in America to-day must appreciate that his work can not endure for all time, except in respect to certain fundamental needs, which must be reasonably permanent for all people under all conditions. But it is manifestly impossible to say in detail what will be essential in the schools fifty years from now. As society becomes differentiated, new needs will arise which will require the establishment of institutions for the training of new groups. If the school is thoroughly plastic, it will from decade to decade revise its curriculum and its methods in respect to the details of its procedure. What is going on in America to-day in the modification of curricula and methods is inevitable in a civilization like our own; and it is bound to continue. Topics of study of importance a hundred years ago may be of relatively little importance to-day. On the other hand, on account of changing social conditions, many topics and subjects may be of worth to-day which would have been of little account a hundred years ago. If the school fulfills its mission, there must be constant evolution, in respect alike to the materials taught and the methods of teaching and of discipline. Nations in which this is not true must sooner or later become decadent.

THE PARADOX OF THE EAST WIND

By Professor ALEXANDER McADIE
BLUE HILL METEOROLOGICAL OBSERVATORY

ABOUT ten miles south of Boston, on the highest land within sight of the sea from Maine to Florida, is a well-known meteorological observatory, founded some thirty years ago by a young graduate of the Massachusetts Institute of Technology. The founder, Lawrence Rotch, became in time the pioneer explorer of the upper air, contributing much to our knowledge of air motion at different levels. In collaboration with Teisserenc de Bort, he may be credited with inaugurating the campaign which resulted in the important discovery of the double character of our atmosphere, as shown by the two great divisions of the stratosphere and the troposphere.

A few years before his death, Rotch, who was then professor of meteorology at Harvard, remodeled the Blue Hill Observatory and on the walls of the new library placed eight symbolized figures of the winds. These were copies in relief of the winged human figures on the frieze of the not-too-well-known Tower of the Winds, which has stood for twenty-odd centuries at the base of the hill crowned by the Acropolis.

The Greek was a past-master in the art of personifying natural phenomena and these figures of the winds are ornamented, clothed and posed so as to suggest the characteristic feature of the particular direction represented. Boreas, an old friend, representing the north wind, is a determined-looking fellow, warmly clad but active in spite of his many wraps and heavy buskins. He carries a conch shell and has been blowing it. The sculptor meant, of course, to represent the boisterous roaring of the north wind, especially noticeable where the air in its passage comes over some range or group of hills. Of all the winds, Boreas is the noisiest. But it is not so much with Boreas, or his companion on the left and fellow noise-maker, the ruffian Skiron, warder of the northwest winds, that we are concerned, as with the east wind, the hopeful, open-faced Apheliotes. Apheliotes Nov. Ang. is perhaps an unfamiliar phrase yet it is only the classical rendering of a very familiar expression, namely, the east wind of New England. And many speak of the east wind as if it belonged to New England alone, associating this stream of surface air, a very shallow current, as we shall show later, with the coast north of Cape Cod, although it prevails along the entire Atlantic seaboard.

It is a wind from the sea, and whether it comes as the gentle, welcome sea-breeze of summer or as the *sea-turn* due to the advancing cyclone from the west, it is still a recognizable ocean wind. Such winds are regarded in most lands with favor. Why then, do we, of the eastern states, hold it in ill repute? At Athens, the east wind, the wind from the sea—the Apheliotes of the Tower—is typified by a young man with hair flowing in every direction. The youth has a fine open countenance and holds with both hands the skirts of his mantle which is filled with fruits and flowers. Along the shores of the Ægean, tillers of the soil, prone to take the weather *an-cha-Allah* (as Allah wills), bow when the east wind blows, echoing the words of one Dervish Mustapha in his greeting

This is a divine wind, for it wafts the blessings of Allah to us from Mecca.

On the Atlantic coast, as elsewhere in the United States, the prevailing winds are westerly. In fact the general movement of the surface air in temperate northern latitudes is from west to east. It is interesting and perhaps worth while to speculate on the climatic changes which would occur if the prevailing flow of air were reversed and the surface current moved from east to west. Then the east wind, the Apheliotes Nov. Ang. would become the prevalent wind. It would not be as now, a shallow intermittent current, but would extend to some height. The Atlantic states would have a balmy, equable climate, with occasional storms from the sea preceded by west winds, rather dry, and followed by moderate east winds and showers. The climate would be like that of Bermuda. East of the Mississippi there would be fewer hot spells, likewise fewer freezes. The cold wave which now follows the "low" would be unknown. The climate of the country west of the Rocky Mountains, however, would be rigorous. Temperature changes would be pronounced on the Pacific coast.

Let us examine now the records of the flow of the air from sea to land and from land to sea, at different levels, as shown by the Blue Hill records. Owing to the sensitiveness of the instruments and the open character of the scales employed, also because there has been no change in exposure or methods, the data are thoroughly comparable and in themselves constitute a unique and valuable contribution to American ærology. It is doubtful if at any other station in our country records of wind direction and velocity are so detailed and complete. Checked by numerous experiments with kites and balloons, the records show that *there is twice as much wind from the west as from the east.* This will surprise many, for the impression is widespread that the climate of the Atlantic seaboard. is determined primarily by the east wind. On the contrary, west winds dominate and control both by duration and velocity. The indictment may seem somewhat sweeping; but so far as we can at present determine, the

west and northwest winds are responsible for the severity of our winter; and the southwest wind for the heat of summer. Counting the actual hours of flow of air in different directions, it appears that the west prevails one fifth of the time, the northwest, nearly as long, and the southwest, one sixth of the whole period. In a year, the west wind blows 1,739 hours, the northwest 1,609 and the southwest 1,412. The total duration of all winds from easterly points of the compass is but 1,950; and the ratio of east to west is as four to ten. The east wind by itself prevails only six hours in a hundred and so can hardly be a controlling factor of the climate. But some one may say: "Granting that the east wind does not blow as long as the winds from other quarters, possibly it blows harder?" No, just the opposite is the case. The mean velocities in meters per second from sea-level up to a mile, are NW. 12, W. 12, SW. 11, N. 11, S. 10, NE. 9, SE. 9 and E. 6. This proves that the east wind is the feeblest of all the winds. Moreover easterly winds blow more frequently in summer than in winter. The east wind is also the current of most uniform velocity, *i. e.*, the least gusty, while our friends Boreas and Skiron true to their reputations are genuine gust makers. The period of greatest gustiness or instability, is the afternoon. All the winds increase in velocity with elevation up to a certain height; but the east and northeast winds are not deep and at an elevation of two kilometers (6,562 feet) these winds rarely occur. There are two kinds of east wind, the cyclonic wind which is moderately strong; and the sea-breeze which is only a few hundred feet in depth. The latter occurs on clear, warm, quiet days and never when the pressure distribution is favorable for turbulent conditions. It does not originate on land but comes in from the sea and seems to push away slowly the quiet, stagnant air in front. The ripples on the water as the breeze works its way landward look like schools of mackerel. On very quiet warm mornings the breeze may arrive as early as ten o'clock. It veers slightly as the sun gets half-way down and dies away as gently as it began. It does not penetrate far inland and its effect in lowering the temperature is limited to a few miles back from the shore. It comes too at a season when the air-gods seemingly are willing to rest, when the storm frequency is a minimum, when the Atlantic and the land have respite from the strenuous succession of storms. Then ceases for a while the rapid alternation of "high" and "low," the alternation which causes the characteristic changeableness for which the east wind is made scapegoat.

Truly men have much to learn about the medium in which they live, the very air they breathe. Paradoxically the orchardist blames the frost, as he sees it, for the damage to his crop, whereas the congealed water in the process of solidifying retards the fall in temperature, giving

out in the unequal fight its own latent heat of fusion, some 80 calories per gram of ice, plus the latent heat of condensation, some 596 calories per gram of water. Similarly men blame the breath of old ocean, the invisible vapor brought in by the east wind, calling it chilly, damp and disagreeable; forgetting that the cold has been caused primarily by the wide-sweeping western winds. Certainly Apheliotes is a water-bearer; he bears and pours, ministering to the desiccate air even as the garden lover bears and pours upon the parched and thirsty beds. For the service rendered, this wind from the water gets small praise, while noisy Boreas and blustering Skiron driving all warmth and moisture before them pass approved of men as health givers.

WAR AND PEACE

A League of Peace

THE futility of war as a means of producing peace between nations has often been dwelt upon. It is really the most futile of all remedies, because it embitters contestants and sows the seeds of future struggles. Generations are sometimes required to eradicate the hostility engendered by one conflict. War sows dragons' teeth, and seldom gives to either party what it fought for. When it does, the spoil generally proves Dead Sea fruit. The terrible war just concluded is another case in point. Neither contestant obtained what he fought for, the reputed victor being most of all disappointed at last with the terms of peace. Had Japan, a very poor country, known that the result would be a debt of two hundred millions sterling loading her down, or had Russia known the result, differences would have been peacefully arbitrated. Such considerations find no place, however, in the fiery furnace of popular clamor; as little do those of cost or loss of life. Only if the moral wrong, the sin in itself, of man-slaying is brought home to the conscience of the masses may we hope speedily to banish war. There will, we fear, always be demagogues in our day to inflame their brutal passions and urge men to fight, as a point of honor and patriotism, scouting arbitration as a cowardly refuge. All thoughts of cost or loss of human life vanish when the brute in man, thus aroused, gains sway.

It is the crime of destroying human life by war and the duty to offer or accept peaceful arbitration as a substitute which need to be established, and which, as we think, those of the church, the universities, and of the professions are called upon to strongly emphasize.

If the principal European nations were not free through conscription from the problem which now disturbs the military authorities of Britain, the lack of sufficient numbers willing to enter the man-slaying profession, we should soon hear the demand formulated for a league of peace among the nations. The subject of war can never be studied without recalling this simplest of all modes for its abolition. Five nations cooperated in quelling the recent Chinese disorders and rescuing their representatives in Pekin. It is perfectly clear that these five nations could banish war. Suppose even three of them formed a league of peace—inviting all other nations to join—and agreed that since war in any part of the civilized world affects all nations, and often seriously, no nation shall go to war, but shall refer international disputes to the Hague conference or other arbitral body for peaceful

settlement, the league agreeing to declare non-intercourse with any nation refusing compliance. Imagine a nation cut off to-day from the world. The league also might reserve to itself the right, where non-intercourse is likely to fail or has failed to prevent war, to use the necessary force to maintain peace, each member of the league agreeing to provide the needed forces, or money in lieu thereof, in proportion to her population or wealth. Being experimental and upon trial, it might be deemed advisable, if necessary, at first to agree that any member could withdraw after giving five years' notice, and that the league should dissolve five years after a majority vote of all the members. Further provisions, and perhaps some adaptations, would be found requisite, but the main idea is here.

The Emperor of Russia called the Hague conference, which gave us an international tribunal. Were King Edward or the Emperor of Germany or the President of France, acting for their governments, to invite the nations to send representatives to consider the wisdom of forming such a league, the invitation would no doubt be responded to and probably prove successful.

The number that would gladly join such a league would be great, for the smaller nations would welcome the opportunity.

The relations between Britain, France and the United States to-day are so close, their aims so similar, their territories and fields of operation so clearly defined and so different, that these powers might properly unite in inviting other nations to consider the question of such a league as has been sketched. It is a subject well worthy the attention of their rulers, for of all the modes of hastening the end of war this appears the easiest and the best. We have no reason to doubt that arbitration in its present optional form will continue its rapid progress, and that it in itself contains the elements required finally to lead us to peace, for it conquers wherever it is tried; but it is none the less gratifying to know that there is in reserve a drastic mode of enforcement, if needed, which would promptly banish war. . . .

Let me close by quoting the words of Lincoln. When a young man, employed upon a trading boat, he made a voyage of some weeks' duration upon the Mississippi. He visited a slave market, where men, women and children were not slaughtered, as formerly in war, but were separated and sold from the auction block. His companion tells that after standing for some time Lincoln turned and walked silently away. Lifting his clenched hand, his first words were, "If ever I get a chance, I shall hit this accursed thing hard." Many years passed, during which he never failed to stand forth as the bitter foe of slavery and the champion of the slave. This was for him the paramount issue. He was true to his resolve throughout life, and in the course of events his time came at last. This poor, young, toiling boatman became president of the United States, and was privileged with a stroke of his pen to

emancipate the slaves last remaining in the civilized world, four millions in number. He kept the faith, and gave the lesson for all of us in our day, who have still with us war in all its enormity, many of us more or less responsible for it, because we have not hitherto placed it above all other evils and concentrated our efforts sufficiently upon its extinction. Let us resolve like Lincoln, and select man-slaying as our foe, as he did man-selling. Let us, as he did, subordinate all other public questions to the one over-shadowing question, and, as he did, stand forth upon all suitable occasions to champion the cause. Let us, like him, keep the faith, and as his time came, so to us our time will come, and, as it does, let us hit accursed war hard until we drive it from the civilized world, as he did slavery.—Andrew Carnegie in the POPULAR SCIENCE MONTHLY for May, 1906.

THE MORAL EQUIVALENT OF WAR

HAVING said thus much in preparation, I will now confess my own utopia. I devoutly believe in the reign of peace and in the gradual advent of some sort of a socialistic equilibrium. The fatalistic view of the war-function is to me nonsense, for I know that war-making is due to definite motives and subject to prudential checks and reasonable criticisms, just like any other form of enterprise. And when whole nations are the armies, and the science of destruction vies in intellectual refinement with the sciences of production, I see that war becomes absurd and impossible from its own monstrosity. Extravagant ambitions will have to be replaced by reasonable claims, and nations must make common cause against them. I see no reason why all this should not apply to yellow as well as to white countries, and I look forward to a future when acts of war shall be formally outlawed as between civilized peoples.

All these beliefs of mine put me squarely into the anti-militarist party. But I do not believe that peace either ought to be or will be permanent on this globe, unless the states pacifically organized preserve some of the old elements of army-discipline. A permanently successful peace-economy can not be a simple pleasure-economy. In the more or less socialistic future towards which mankind seems drifting we must still subject ourselves collectively to those severities which answer to our real position upon this only partly hospitable globe. We must make new energies and hardihoods continue the manliness to which the military mind so faithfully clings. Martial virtues must be the enduring cement; intrepidity, contempt of softness, surrender of private interest, obedience to command, must still remain the rock upon which states are built—unless, indeed, we wish for dangerous reactions against commonwealths fit only for contempt, and liable to invite attack whenever

a center of crystallization for military-minded enterprise gets formed anywhere in their neighborhood.

The war-party is assuredly right in affirming and reaffirming that the martial virtues, although originally gained by the race through war, are absolute and permanent human goods. Patriotic pride and ambition in their military form are, after all, only specifications of a more general competitive passion. They are its first form, but that is no reason for supposing them to be its last form. Men now are proud of belonging to a conquering nation, and without a murmur they lay down their persons and their wealth, if by so doing they may fend off subjection. But who can be sure that *other aspects of one's country* may not, with time and education and suggestion enough, come to be regarded with similarly effective feelings of pride and shame? Why should men not some day feel that it is worth a blood-tax to belong to a collectivity superior in *any* ideal respect? Why should they not blush with indignant shame if the community that owns them is vile in any way whatsoever? Individuals, daily more numerous, now feel this civic passion. It is only a question of blowing on the spark till the whole population gets incandescent, and on the ruins of the old morals of military honor, a stable system of morals of civic honor builds itself up. What the whole community comes to believe in grasps the individual as in a vise. The war-function has grasped us so far; but constructive interests may some day seem no less imperative, and impose on the individual a hardly lighter burden.

Let me illustrate my idea more concretely. There is nothing to make one indignant in the mere fact that life is hard, that men should toil and suffer pain. The planetary conditions once for all are such, and we can stand it. But that so many men, by mere accidents of birth and opportunity, should have a life of *nothing else* but toil and pain and hardness and inferiority imposed upon them, should have *no* vacation, while others natively no more deserving never get any taste of this campaigning life at all—*this* is capable of arousing indignation in reflective minds. It may end by seeming shameful to all of us that some of us have nothing but campaigning, and others nothing but unmanly ease. If now—and this is my idea—there were, instead of military conscription a conscription of the whole youthful population to form for a certain number of years a part of the army enlisted against *nature*, the injustice would tend to be evened out, and numerous other goods to the commonwealth would follow. The military ideals of hardihood and discipline would be wrought into the growing fiber of the people; no one would remain blind as the luxurious classes now are blind, to man's real relations to the globe he lives on, and to the permanently sour and hard foundations of his higher life. To coal and iron mines, to freight trains, to fishing fleets in December, to dishwashing, clothes-washing and window-washing, to road-building and tunnel-

making, to foundries and stoke-holes, and to the frames of skyscrapers, would our gilded youths be drafted off, according to their choice, to get the childishness knocked out of them, and to come back into society with healthier sympathies and soberer ideas. They would have paid their blood-tax, done their own part in the immemorial human warfare against nature, they would tread the earth more proudly, the women would value them more highly, they would be better fathers and teachers of the following generation.

Such a conscription, with the state of public opinion that would have required it, and the many moral fruits it would bear, would preserve in the midst of a pacific civilization the manly virtues which the military party is so afraid of seeing disappear in peace. We should get toughness without callousness, authority with as little criminal cruelty as possible, and painful work done cheerily because the duty is temporary, and threatens not, as now, to degrade the whole remainder of one's life. I spoke of the "moral equivalent" of war. So far, war has been the only force that can discipline a whole community, and until an equivalent discipline is organized, I believe that war must have its way. But I have no serious doubt that the ordinary prides and shames of social man, once developed to a certain intensity, are capable of organizing such a moral equivalent as I have sketched, or some other just as effective for preserving manliness of type. It is but a question of time, of skillful propagandism, and of opinion-making men seizing historic opportunities.

The martial type of character can be bred without war. Strenuous honor and disinterestedness abound elsewhere. Priests and medical men are in a fashion educated to it, and we should all feel some degree of it imperative if we were conscious of our work as an obligatory service to the state. We should be *owned,* as soldiers are by the army, and our pride would rise accordingly. We could be poor, then, without humiliation, as army officers now are. The only thing needed henceforward is to inflame the civic temper as past history has inflamed the military temper. H. G. Wells, as usual, sees the center of the situation. "In many ways," he says, "military organization is the most peaceful of activities. When the contemporary man steps from the street, of clamorous insincere advertisement, push, adulteration, underselling and intermittent employment, into the barrack-yard, he steps on to a higher social plane, into an atmosphere of service and cooperation and of infinitely more honorable emulations. Here at least men are not flung out of employment to degenerate because there is no immediate work for them to do. They are fed and drilled and trained for better services. Here at least a man is supposed to win promotion by self-forgetfulness, and not by self-seeking. And beside the feeble and irregular endowment of research by commercialism, its little short-sighted snatches at profit by innovation and scientific economy, see how remarkable is the

steady and rapid development of method and appliances in naval and military affairs! Nothing is more striking than to compare the progress of civil conveniences which has been left almost entirely to the trader, to the progress in military apparatus during the last few decades. The house-appliances of to-day, for example, are little better than they were fifty years ago. A house of to-day is still almost as ill-ventilated, badly heated by wasteful fires, clumsily arranged and furnished as the house of 1858. Houses a couple of hundred years old are still satisfactory places of residence, so little have our standards risen. But the rifle or battleship of fifty years ago was beyond all comparison inferior to those we possess; in power, in speed, in convenience alike. No one has a use now for such superannuated things."[1]

Wells adds[2] that he thinks that the conceptions of order and discipline, the tradition of service and devotion, of physical fitness, unstinted exertion and universal responsibility, which universal military duty is now teaching European nations, will remain a permanent acquisition, when the last ammunition has been used in the fireworks that celebrate the final peace. I believe as he does. It would be simply preposterous if the only force that could work ideals of honor and standards of efficiency into English or American natures should be the fear of being killed by the Germans or the Japanese. Great indeed is fear; but it is not, as our military enthusiasts believe and try to make us believe, the only stimulus known for awakening the higher ranges of men's spiritual energy. The amount of alteration in public opinion which my utopia postulates is vastly less than the difference between the mentality of those black warriors who pursued Stanley's party on the Congo with their cannibal war-cry of "meat! meat" and that of the "general staff" of any civilized nation. History has seen the latter interval bridged over: the former one can be bridged over much more easily.—William James in the POPULAR SCIENCE MONTHLY for October, 1910.

WAR AND MANHOOD

THOSE who fall in war are the young men of the nations, the men between the ages of eighteen and thirty-five, without blemish so far as may be—the men of courage, alertness, dash and recklessness, the men who value their lives as naught in the service of the nation. The man who is left is for better and for worse the reverse of all this, and it is he who determines what the future of the nation shall be.

However noble, encouraging, inspiring, the history of modern Europe may be, it is not the history we should have the right to expect from the development of its racial elements. It is not the history that would have been made by these same elements released from the shadow

[1] "First and Last Things," 1908, p. 215.

[2] *Ibid.*, p. 226.

of the reversed selection of fratricidal war. And the angle of divergence between what might have been and what has been, will be determined by the percentage of strong men slain on the field of glory.

And all this applies, not to one nation nor to one group of nations alone, but in like degree to all nations, which have sent forth their young men to the field of slaughter. As with Greece and Rome, as with France and Spain, as with Mauritania and Turkestan, so with Germany and England, so with all nations who have sent forth "the best they breed" to the foreign service, while cautious, thrifty mediocrity filled up the ranks at home.

In his charming studies of "Feudal and Modern Japan," Mr. Arthur Knapp, of Yokohama, returns again and again to the great marvel of Japan's military prowess after more than two hundred years of peace. This was shown in the Chinese war. It has been more conclusively shown on the fields of Manchuria since Mr. Knapp's book was written. It is astonishing to him that, after more than six generations in which physical courage has not been demanded, these virile virtues should be found unimpaired. We can readily see that this is just what we should expect. In times of peace there is no slaughter of the strong, no sacrifice of the courageous. In the peaceful struggle for existence there is a premium placed on these virtues. The virile and the brave survive. The idle, weak and dissipated go to the wall. "What won the battles on the Yalu, in Korea or Manchuria," says the Japanese, Nitobe, "was the ghosts of our fathers guiding our hands and beating in our hearts. They are not dead, these ghosts, those spirits of our war-like ancestors. Scratch a Japanese, even one of the most advanced ideas, and you will find a Samurai." If we translate this from the language of Shintoism to that of science we find it a testimony to the strength of race-heredity, the survival of the ways of the strong in the lives of the self-reliant.

If after two hundred years of incessant battle Japan still remained virile and warlike, that would indeed be the marvel. But that marvel no nation has ever seen. It is doubtless true that war-like traditions are most persistent with nations most frequently engaged in war. But the traditions of war and the physical strength to gain victories are very different things. Other things being equal, the nation which has known least of war is the one most likely to develop the "strong battalions" with whom victory must rest.

As Americans we are more deeply interested in the fate of our mother country than in that of the other nations of Europe.

What shall we say of England and of her relation to the reversed selection of war?

Statistics we have none, and no evidence of tangible decline that Englishmen will not indignantly repudiate. When the London press in the vacation season fills its columns with editorials on English

degeneration, it is something else to which these journalists refer. Their problem is that of the London slums, of sweat-shops and child-labor, of wasting overwork and of lack of nutrition, of premature old age and of sodden drunkenness—influences which bring about the degeneration of the individual, the inefficiency of the social group, but which for the most part leave no trace in heredity and are therefore no factor in the degeneration of the race. Such degradation is at once cause, effect and symptom—a sign of racial inadequacy, a cause of further enfeeblement and an effect of unjust and injurious social, political and industrial conditions in the past.

But the problem before us is not the problem of the slums. What mark has been left on England by her great struggles for freedom and by the thousand petty struggles to impose on the world the semblance of order called "Pax Britannica," the British peace?

To one who travels widely through the counties of England some part of the cost is plain.

> There's a widow in sleepy Chester
> Who mourns for her only son;
> There's a grave by the Pabeng River—
> A grave which the Burmans shun.

This is a condition repeated in every village of England, and its history is recorded on the walls of every parish church. Everywhere can be seen tablets in memory of young men—gentlemen's sons from Eton and Rugby and Winchester and Harrow, scholars from Oxford and Cambridge, who have given up their lives in some far-off petty war. Their bodies rest in Zululand, in Cambodia, in the Gold Coast, in the Transvaal. In England only they are remembered. In the parish churches these records are numbered by the score. In the cathedrals they are recorded by the thousand. Go from one cathedral town to another—Canterbury, Winchester, Chidester, Exeter, Salisbury, Wells, Ely, York, Lincoln, Durham, Litchfield, Chester (what a wonderful series of pictures this list of names calls up!), and you will find always the same story, the same sad array of memorials to young men. What would be the effect on England if all of these "unreturning brave" and all that should have been their descendants could be numbered among her sons to-day? Doubtless not all of these were young men of character. Doubtless not all are worthy even of the scant glory of a memorial tablet. But most of them were worthy. Most of them were brave and true, and most of them looked out on life with "frank blue Briton eyes."

This too we may admit, that war is not the only destructive agency in modern society, and that in the struggle for existence the England of to-day has had many advantages which must hide or neutralize the waste of war.

It suggests the inevitable end of all empire, of all dominion of man

over man by force of arms. More than all who fall in battle or are wasted in the camps, the nation misses the "fair women and brave men" who should have been the descendants of the strong and the manly. If we may personify the spirit of the nation, it grieves most not over its "unreturning brave," but over those who might have been but never were, and who, so long as history lasts, can never be.

It is claimed that by the law of probabilities as developed by Quetelet, there will appear in each generation the same number of potential poets, artists, investigators, patriots, athletes and superior men of each degree. But this law has no real validity. Its pertinence involves the theory of continuity of paternity, that in each generation a percentage practically equal of men of superior force or superior mentality should survive to take the responsibilities of parenthood. Otherwise Quetelet's law becomes subject to the operation of another law, the operation of reversed selection, or the biological "law of diminishing returns." In other words, breeding from an inferior stock is the sole agency in race degeneration, as selection natural or artificial along one line or another is the sole agency in race progress.

And all laws of probabilities and of averages are subject to a still higher law, the primal law of biology, which no cross-current of life can overrule or modify: Like the seed is the harvest.

And because this is true, arises the final and bitter truth: "Wars are not paid for in war time. The bill comes later!"—David Starr Jordan in the POPULAR SCIENCE MONTHLY for January, 1911.

SCIENCE AND INTERNATIONAL GOOD WILL

SCIENCE with its applications has been one of the principal factors leading to peace and international good will. Science, democracy and the limitation of warfare are the great achievements of modern civilization. They have advanced together almost continuously from the beginnings of the universities of Bologna, Paris and Oxford in the twelfth century to their great triumphs in the nineteenth century and the present promise of their complete supremacy. It may be urged reasonably that science is the true cause of democracy and that science and democracy together are the influences most conducive to permanent and universal peace.

The applications of science in industry, agriculture and commerce, in the prevention of disease and of premature death, have abolished the need of excessive manual labor. It long ago became unnecessary for the great majority of the people to be held in bondage in order that a few free citizens might have education and opportunity, and slavery has been gradually driven from the world. The vast progress of scientific discovery and invention in the nineteenth century has reduced to a moderate amount the daily labor required from each in order that all

may be adequately fed, clothed and housed. The death-rate has been decreased to one half; the ensuing lower birth-rate has freed nearly half the time of women and reduced proportionately the labor of men. The period of childhood and youth may be devoted to universal education, and equality of opportunity can be given to all. It is no longer needful to depend on a privileged class to conduct the affairs of government and to supply men of performance. Those selected from all the people as most fit can be given the preparation and opportunity needed to enable them to become leaders, and every one can take an intelligent share in political affairs and in appreciation of the higher things of life.

In giving us democracy science has made its greatest contribution to the limitation of warfare. It must be admitted that a democratic people may be inflamed into a mob mad for war; but this is not likely to happen in the case of a war of policy or of aggression. In the past wars have been more often due to the ambitions, difficulties and intrigues of kings and princes than to the passions of the people, and the decrease of wars has been largely a result of the establishment of constitutional governments and of the legalization of the methods of conscription and taxation. If a declaration of war or an ultimatum leading to war were subject to a referendum, the vote being taken not too promptly, and if the estimated cost of the war were collected in taxes in advance, there would not be many wars.

We are still far from having a true political and social democracy. The production of wealth has increased rapidly; but we have not learned to distribute it justly or to use it wisely. The education supplied by our schools is inadequate and inept. We may be confident that a complete democracy will be the strongest force for peace that the world has seen. Even now the great mass of the people, most of them having some education and some property, are the true guarantees against wanton war. A king can no longer summon his nobles and the chiefs gather together their retainers to invade a foreign country. A war which, with its accompanying pestilence and famine, would reduce the population of a country to one half, as in the case of the thirty years' war, is now almost inconceivable. And this we owe to social and political democracy, which in turn we owe to science.

As a result of scientific progress and invention, the law of Malthus has been reversed. The means of subsistence increase more rapidly than the population. The sinister voluntary limitation of childbirth, which may give rise to racial deterioration and actual depopulation, is unnecessary. As population increases under a given condition of culture, the number of men of genius and talent competent to make the labor of each more efficient increases in proportion; as their inventions are of benefit to all, the means of subsistence tend to increase as the square of the population. As the level of education and culture is

raised, and as democracy is perfected, so that each is given opportunity to do the work for which he is fit, the wealth and means of subsistence increase still more rapidly. The law of Malthus and the law of diminishing returns, like the law of the degradation of energy, may ultimately prevail, but not in any future with which we are concerned. The population of a civilized country, in which science is cultivated, need not be limited by famine, pestilence or war. Over-population and the need of expansion by conquest are obviated by democracy and science; the cause of war which may be regarded as inevitable and legitimate is thus abolished. In providing adequately for the subsistence of an increasing population, science has made a contribution to peace the magnitude of which can not be easily overstated.

Another great service for peace to be credited to science is the development of commerce, travel and intercommunication. Steam and electricity are handmaids of peace. Trade disputes and the misadventures of missionaries, travelers and immigrants may serve as causes or pretexts of wars, but the balance of commerce, travel and immigration is large on the side of peace. With the existing commerce among the nations, each dependent on every other, a war of any kind does injury to all. A nation at war destroys its own property throughout the world, and all the nations suffer. A neutral nation can no more afford to countenance a needless war than mobs burning its own cities and killing its own citizens. In New York, London, Berlin and Paris are business houses and representatives of every country in the world. How could any nation wish to destroy or to permit the destruction of these cities? . . .

Science has given us democracy, it has given us ample means of subsistence, it has given us commerce and intercommunication, and these three achievements are the principal factors which have lessened warfare and will eventually lead to its complete abolition. Other contributions of science, though less momentous, are by no means unimportant. Warfare is now in large measure applied science, and this tends towards its decrease. Wars between nations with scientific equipment and savage and barbarous peoples are no longer waged on equal terms and are of short duration. The extermination, despoliation and subjugation of the non-Caucasian races may be the world's great tragedy, and in so far as some of these peoples are able to adopt our science there will be a readjustment which may be written in blood or may be a triumph of common sense and justice. However this may be, the invincibility that science has conferred on the western nations has made them safe from attack and invasion, and while it may on occasion have led to wanton aggression, it has, on the whole, limited warfare. If we call to mind the centuries of invasion and threats of invasion by Northmen, Ottomans and Saracens, we can appreciate the value of the means of defense which science has given to the civilized nations.

The making of warfare an applied science by the western nations and by one eastern nation has tended also to prevent war between nations so equipped. When war is a game of skill rather than of chance, it is likely to be undertaken only after careful consideration of the conditions and consequences. The cost is enormous and must be carefully weighed. The interests of the money lenders are usually on the side of peace and become increasingly so as war continues. If war does occur between two great nations it is likely to be of short duration. It can not drag on through tens of years as formerly. Its horrors are also reduced; non-combatants are not so much concerned, and soldiers suffer less from disease—far more dreadful than violence—owing to the shorter duration of wars and to hygiene, medicine and surgery. It may be hoped that science has accomplished, on the whole, more for defense than for aggression; torpedoes, mines, submarines and aeroplanes are more effective for protection than for attack. The cost of modern armaments is so immense that this in itself will lead to their limitation and to the settlement of difficulties otherwise than by appeal to arms.

There is a psychological aspect of modern scientific warfare, which tends to discredit it. The heroism and the bravery, the excitement of personal contact and the exhibition of personal prowess, the romance and the occasional chivalry, are largely gone. Men cooped up in battleships or displayed like pawns on the field are not much greater heroes to themselves or to others than workers in a mine exposed to nearly equal danger. Officers under constant instructions from the seat of government and telegraphing their orders from a point of safety fall to the level of ordinary men of affairs. Tin soldiers will not forever stir the imagination of children in the nursery. Providence is on the side favored by the money lenders and having the best organized commissariat. War becomes brutal and disgusting; at its best like the business of the hangman, at its worst like infanticide.—J. McKeen Cattell in the POPULAR SCIENCE MONTHLY for April, 1912.

THE PROGRESS OF SCIENCE

THE MAD WAR

AN obscure French war of the fifteenth century is known to historians as the *guerre folle*, but no carnage so well deserves to be called the "mad war" as the international slaughter now raging in Europe. There existed an inevitable conflict of inherited memories between Germany and France, an inevitable commercial conflict between Germany and Great Britain, an inevitable racial conflict between Teutons and Slavs. But these conflicts might have been carried forward to the benefit of civilization instead of for its subversion. The decrease in the death rate, the maintenance of the birth rate, the care and education of children, the improvement of the condition of the laboring classes, the lessening of pauperism, waste, vice and crime, the decrease of debts and the accumulation of wealth, the progress of science and its applications to manufactures and commerce—these are the conditions of national greatness, and each nation as it advances adds to the welfare of its rivals even while it may outstrip them.

Warfare results in the reverse of all these, scarcely less for the nations which win than for those which lose. It is terribly obvious that the death rate is increased both by violence and by disease. The birth rate must decline for a time and afterwards venereal disease is spread broadcast. A recent test in England showed that only one man in a hundred of those apparently in good health gave the reaction for syphilis, while 19 per cent. of those who had been in the army showed the signs of infection. In time of war children are neglected and their interests perverted. In the Franco-German war a hundred and fifty thousand men died, leaving a corresponding host of widows and orphans.

> Lass sie betteln geh'n,
> Wenn sie hungrig sind.

"Let them beg if they are hungry." Women are in time of war thrust back from their slow advance to equality with men. The laboring classes have the bonds of their industrial slavery more closely drawn. The rich also suffer, though there are always vultures who glut themselves. In the Franco-German war England supplied to half a million French soldiers shoes with paper soles. In the present war the international commerce of Germany, amounting to over three billion dollars a year, will be annihilated. Great Britain, Germany and France have each voted already credits of a billion dollars for the taxing of future generations and a paper wealth by which the well-to-do exploit the poor. Each day of the war more money will be wasted than is needed to endow a university such as Berlin. Everywhere the energies of men are diverted from scientific and social progress to destruction.

Even a pan-European war does not mean the bankruptcy or suicide of civilization. The hundred and fifty thousand men of France who died in their war are after all a lesser sacrifice than the three million children who each year die needlessly in Russia. Alcohol costs more in wealth and health and lives than any war. Warfare is only a vast dramatic exhibition of our savage origin and semi-barbaric condition. In spite of their bureaucratic military organizations, the great nations of Europe had postponed war for more than forty years. Even now both the governments and the peoples of Great Britain, Russia, Italy and Belgium were dis-

posed to peace. In the United States no mob spirit of war was stirred by the president's invasion of Mexico, and the sympathies of our people are against the aggressor in the wanton war of Europe. There we may look for a second Napoleon the little rather than for a second Napoleon the great. Never again will there be a thirty years' war, destroying over half the population of a great nation. Slowly but surely the energies of men are turning toward peace on earth and good will among its nations.

THE RACES OF THE EUROPEAN NATIONS AND THEIR NATURAL INCREASE

THE official German justification of the mad and wanton European war is that it is a defense of the Teutonic culture and people against the semi-Asiatic and barbaric Slav hordes. The verdict of history will probably be that it was a war of calculation for caste and national aggrandizement and a war of miscalculation. The German emperor and his bureaucratic military entourage probably held that the time was ripe for an extension of German influence in the Balkans and towards Asia Minor, with an increase of its African possessions at the expense of France. But it is by no means clear why, if the serpent was prepared to use its fangs, it did not show its alleged wisdom. If after the rough ultimatum and attack of Austria on Servia, Germany had waited in preparation, it would apparently have been in far better position. If Russia had attacked Austria on behalf of Servia, Germany could have gone to the defense of Austria and had its will in the Balkans. If France had then attacked Germany, Italy could only have avoided war on France by breaking its treaty; Great Britain and Belgium would probably have remained neutral.

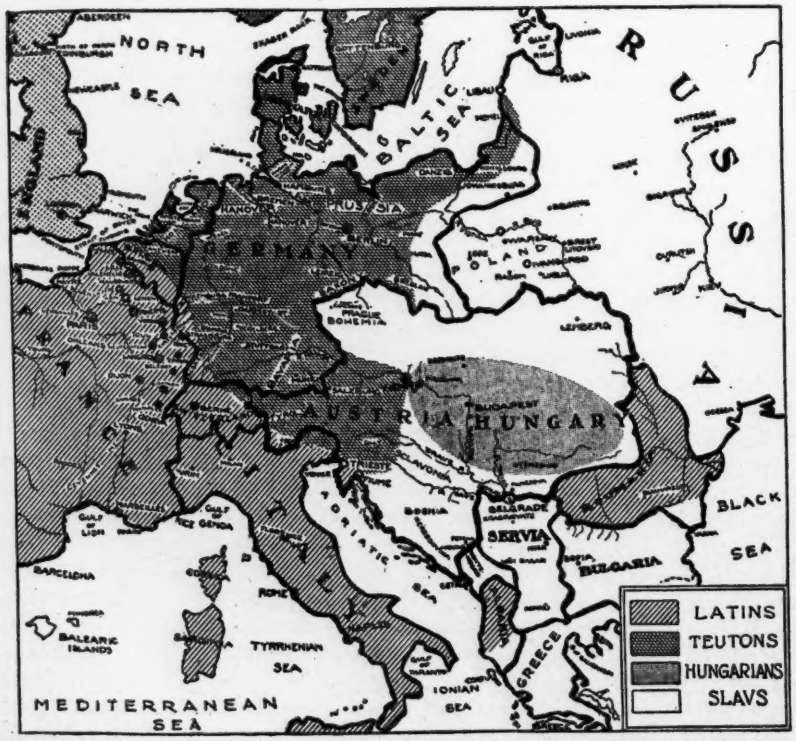
The calculation in Berlin was probably that the time had come for the use of its perfected military machine for its glorification at home and abroad. They knew that the Balkan states were at odds with one another, that there were internal disorders in Russia, which was improving its military system and would have four dreadnoughts ready in the autumn, that France had made large appropriations for defensive works and armaments and had increased the period of military service, that England was on the edge of civil war; they assumed that they would have the support of Italy and Turkey, that Japan was not in question, that Belgium would permit the use of its territory, that Great Britain might submit, that a quick and crushing attack on France would give them a war indemnity and new possessions in Africa and that they would then be able to turn the whole force of their arms on Russia. In so far as this was the calculation at Berlin, it has in part, miscarried; the rest lies on the knees of the gods.

A glance at the accompanying map shows roughly the distribution of the races in Europe. National sentiment is somewhat dependent on racial origin, on language, on religion and on other institutions; but only in a temporary and limited way. All the nations of Europe are composed of peoples of complex racial descent. Switzerland maintains admirably its national homogeneity with diverse races and languages. Protestant Prussia has united with catholic Bavaria. Austria is a complex of nations, languages and races. New York is a collection of cities of diverse nationality, race, language, religions and institutions. In the present war there can be no real conflict of Teuton and Slav, when the Austrian population is more Slav than Teuton and German dominion has already encroached on Slavic population to the east. There may result a change in national boundaries, but scarcely of racial dominance. Germany has already as an evil inheritance from Bismarck a small French population on its west. It can only annex the northern coast of France and Belgium at an untold cost for a future

generation; the same holds for Russian Poland and the Baltic provinces. Russia has better claims to reconstruct an autonomous Poland and annex parts of Austria.

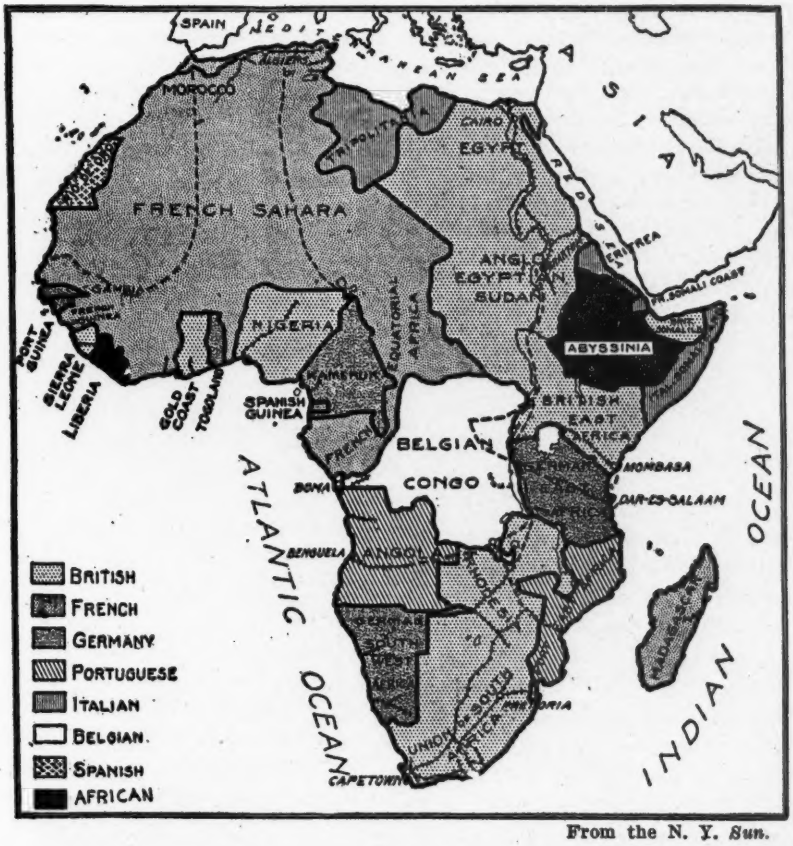
We may hope in the interest of future peace that the map of Europe will not be considerably altered. The chief changes are likely to be in Africa where apart from the English and Dutch in the south there are no real colonies, only exploiting "protectorates." Great Britain controls nearly 2,800,000 square miles, France some 2,300,000 square miles, Germany nearly 1,000,000 square miles; Belgium, Portugal and Italy possess large areas. If Germany loses in the war, Great Britain is almost certain to seize German East Africa to control the path from the Cape to Cairo. France, Belgium, Italy and Portugal will probably increase their holdings at the cost of Germany. If Germany should dominate Europe, it will seek to control Africa and to increase instead of losing its possessions in the far east. It will aim to supplant Great Britain as a world-wide empire.

But the time has probably gone by when Germany can establish colonies as Great Britain did. It may rule subject races as Great Britain does in India, but it can not supply men for colonies such as Canada and the Australian commonwealth. In 1850 German-born residents of the United States outnumbered a hundredfold those born in Austria-Hungary, Russia and Italy together, now the immigration from each of these nations is ten times that from Germany. There are some 13,000,000 Germans in North and South America, but the total emigration from Germany to the United States has de-



From the N. Y. *Evening Post.*

BOUNDARIES OF CENTRAL EUROPE AND THE DISTRIBUTION OF RACES.



From the N. Y. *Sun*.

THE EUROPEAN POSSESSIONS IN AFRICA.

creased to 25,000 and to all other non-European countries to one or two thousand. The birth rate in the city of Berlin has fallen from 40 per thousand to 20 per thousand. Germany has no larger population than it can provide for and needs at home. It has none to spare for emigration, still less for the field of battle.

The birth rate and the natural increase of population are the fundamental factors in racial advance. The Slavs have overrun northwestern Europe and will continue to spread to the south and west. Their natural increase of population far exceeds that of Germany, and will do so increasingly as the death rate declines in Russia and the birth rate continues to decline in Germany. There are now three Russian children born for each German child. How can Germany's army of four million soldiers contend against a surplus of five million children born each year in Russia? If Germany had waited a little longer for its war, England would have been on its side. But nothing except a decline in the Russian birth rate can check its ultimate triumph. We can only hope that it will be a victory of peace and civilization.

SCIENTIFIC ITEMS

WE record with regret the death of Dr. Francis Humphreys Storrer, long professor of agricultural chemistry at Harvard University; of the Rev. Horace Carter Hovey, known for his publications on caverns; of Dr. Frederic Lawrence Kortright, professor of chemistry

at the University of West Virginia; of Professor Franklin William Hooper, director of the Brooklyn Institute of Arts and Sciences; of Professor Albert Smith Bickmore, emeritus head of the department of public instruction of the American Museum of Natural History; of the Rev. Osmond Fisher, at one time tutor of Jesus College, Cambridge, known for his important contributions to geology, and of Professor Paul Reclus, the distinguished Paris surgeon.

DR. CHARLES W. ELIOT, president emeritus of Harvard University, has been elected a corresponding fellow of the British Academy.—Professor Elie Metchnikoff, assistant director of the Institut Pasteur, will next year celebrate his seventieth birthday and the fiftieth anniversary of his doctorate. A committee has been formed, under the presidency of Dr. Roux, director of the Institut Pasteur, for the celebration of the anniversary which will include the publication of a "Festschrift."

THE following American scientific men have accepted invitations to attend the Australasian meeting of the British Association as the guests of the New Zealand government: Dr. C. G. Abbot, Smithsonian Institution; Dr. L. H. Bailey, Cornell University; Mr. Lyman J. Briggs, Department of Agriculture; Professor A. P. Coleman, University of Toronto; Dr. Edwin G. Conklin, Princeton University; Dr. Charles B. Davenport, Carnegie Institution; Professor William M. Davis, Harvard University; Dr. George A. Dorsey, Field Museum of Natural History; President G. C. Creelman, Ontario Agricultural College, Guelph; Professor R. T. Ely, University of Wisconsin; Professor E. C. Franklin, Stanford University; Professor P. H. Hanus, Harvard University; President E. F. Nichols, Dartmouth College; Dr. Ira Remsen, The Johns Hopkins University; Professor William M. Wheeler, Bussey Institution, Harvard University.

MR. ASA G. CHANDLER has given $1,000,000 and citizens of Atlanta have guaranteed $500,000 for the establishment of an Atlanta University, under the auspices of the Methodist Church. It is said that a theological school will be the first to be opened.